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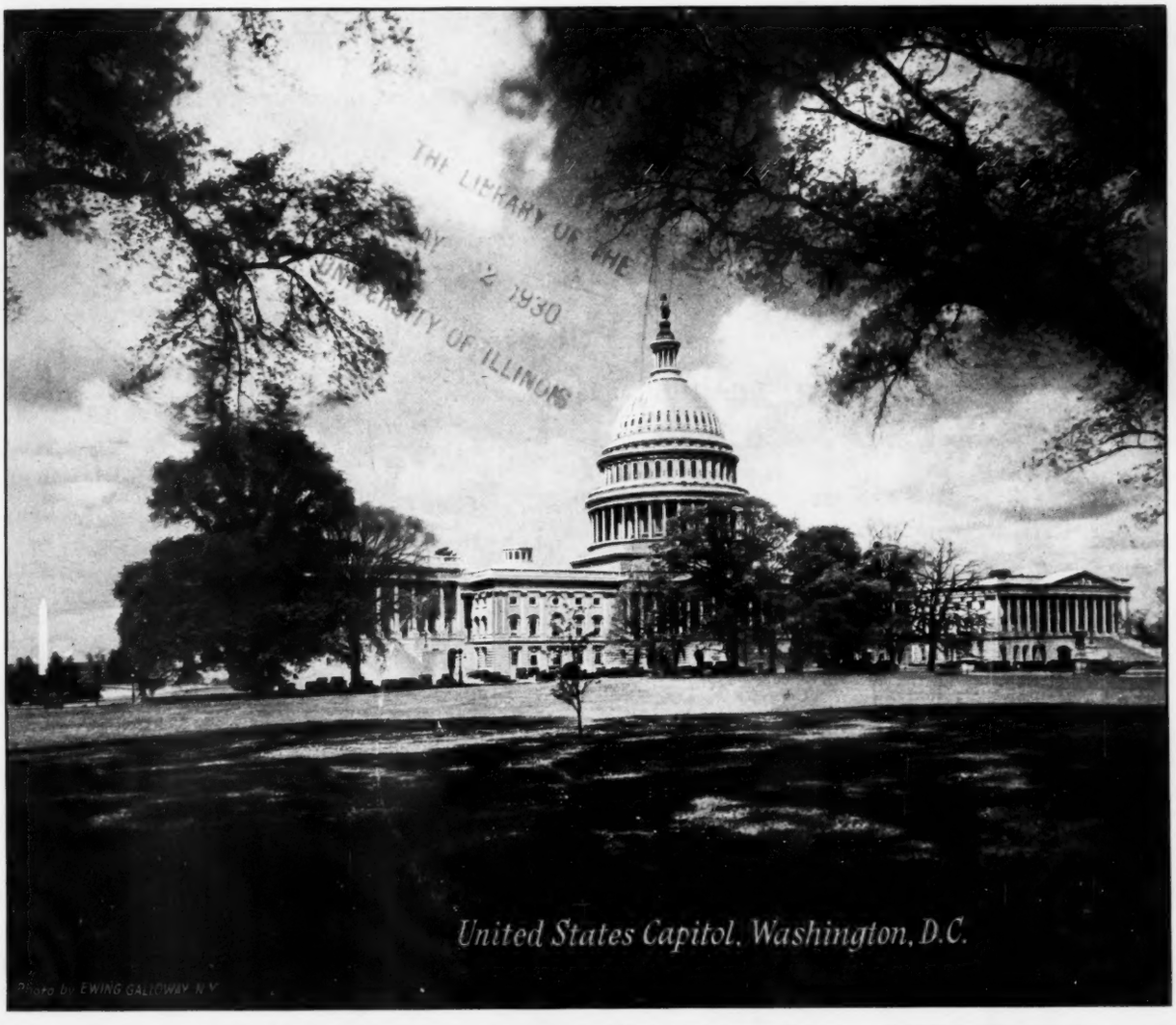
IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING



United States Capitol, Washington, D.C.

Photo by EWING GALLOWAY N.Y.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

May 1930

RAYMOND ROLLER MILLS

18,250,000 TONS OF COAL

per year is the capacity of Raymond Roller Mills installed in power plants of the United States—or 40% of the total coal consumed by the Central Station Industry in 1929.

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Gorgas Station

City of Detroit
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Mistersky Station

Cleveland Elec. Illuminating Co.
Cleveland, Ohio
Lakeshore Station
Avon Station
20th Street Station
Ashtabula Station

Comal Power Company
San Antonio, Texas
Comal Station

Consolidated Gas, E. L. & P. Co.
Baltimore, Md.
Gould Street Station

Delaware River Mfg. Co.
Penns Grove, N. J.
Deepwater Station

Detroit Edison Co.
Detroit, Mich.
Trenton Channel Station

Duke Power Company
Charlotte, N. C.
Buck Steam Station

Duquesne Light Company
Pittsburgh, Pa.
Colfax Station

Illinois Electric Power Co.
Peoria, Ill.
Peoria Station

Metropolitan Power Company
Middletown, Pa.
Susquehanna Station

The Mil. Elec. R'y & Lt. Co.
Milwaukee, Wisconsin
Lakeside Station

Montaup Electric Company
Fall River, Mass.
Somerset Station

Narragansett Electric Company
Providence, R. I.
Eddy Street Station

New JerseyPower & Light Co.
Dover, N. J.
Holland Station

New York Edison Company
New York, N. Y.
East River Station

Public Service Co. of Denver, Colorado
Valmont Station

St. Paul Gas Light Company
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Sioux City Gas & Electric Co.
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COMBUSTION ENGINEERING CORPORATION
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Mechanical Engineering

The Monthly Journal Published by

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Julio Kilenyi, Sculptor

FIFTIETH ANNIVERSARY MEMORIAL TABLET

MECHANICAL ENGINEERING

Volume 52 May, 1930 No. 5

A.S.M.E. 50th Anniversary

An Impression of the Celebration and the Thoughts Expressed in the Principal Addresses

IN THIS year of grace, 1930, when it is given to civilized men to combat fear with knowledge—and to cast off the spell of impotence which has held them slaves to physical environment, we pause momentarily to take stock of progress and to ponder trends. The Fiftieth Anniversary Celebration of The American Society of Mechanical Engineers, to which this May issue of MECHANICAL ENGINEERING is largely devoted, brought together for this purpose from Europe, Asia, Africa, Australia, and North and South America, distinguished engineers who testified to the economic and social effects of engineering and science on the progress of civilization in the countries which they represented. The testimony was impressive and authoritative, and as evidence of these influences the newspapers report engineering progress day by day and reflect the dependence of modern society on engineering and science. From them the average man forms his opinions.

I like to claim for our profession that it is the oldest in the world. For the engineer goes back to Prometheus, who brought down fire from Heaven and subdued it in the service of mankind; to that engineer-artificer, who learned how to chip a bit of flint into the form of a spearhead; to that scientist-engineer who discovered the secret of the bow and arrow; to the engineer who hollowed out a log to convey himself over the water; to the engineer who felled a tree to cross a stream; to Tubal Cain, that cunning artificer in metal; and to the inventors of the wheel and axle, the wedge, and the lever.

We are indeed their inheritors over a span of certainly not less than 25,000 years, and what is our short life of fifty years compared to that? If the inheritance of this long period of gradual evolution and development is ours, if we have received a charge, so shall we be held accountable therefor; so shall we be expected to serve earnestly and faithfully for the advancing benefits of civilization.—From an address by Dr. W. F. Durand at the Anniversary Dinner.

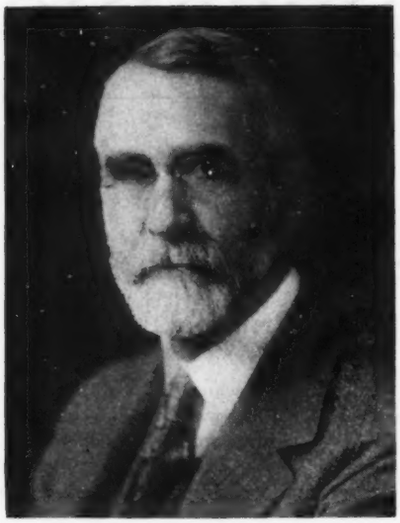
What is the picture that arises out of the newspaper columns? Explorers, no less intrepid than their predecessors who depended upon more primitive means of travel, fly to the South Pole through the air from a snug, well-equipped base in the Antarctic, in constant communication with the rest of the world by means of the radio. The story of their venture is brought back to the civilized world by the motion-picture camera, which, from its elevation, sees more and records it more truly than could weary months of land-bound travel with sledges and sketchbooks. Other aviators, brought down in mid-ocean, for the first time succeed in spending the night in their plane and continuing their flight in the morning. A fleet of dirigibles to link two continents is reported. Two other continents are brought closer together by means of the radio telephone, and presidents of republics exchange greetings while their peoples listen. The king of England addresses the entire world. The Japanese hear their representatives speaking from London. German shipbuilders reduce the time of passage between Cherbourg and Ambrose Light to 4 days, 17 hours, and 6 minutes, making an average speed of 27.99 knots.

These achievements forge the chains that bind nations together in peaceful relationship and understanding. The inhabitants of the countries that have felt the quickening touch of engineering science, live in houses whose comforts and conveniences shame the palaces of a century ago. They are protected from pestilence. They work in shops that are adequately lighted and heated, where attention is given to their safety and creature comforts; and their labor has been so lightened that they may enjoy their greater hours of leisure and the greater satisfactions that their more adequate incomes bring.

Such a picture expands the soul—but what of its other side? Crimes of lust and passion still stain the pages of these same newspapers. Suspicion still lurks in the minds of men questioning the methods and intentions of others. Men still submit to dictators and minorities, and demagogs defeat the purposes of democratic institutions by means of selfishness, bigotry, and intolerance. There are still vast areas of the world where savagery persists; and in all civilized countries unemployment and poverty, ugliness and ignoble living, mock the disciples of progress. The fundamental nature of man is much as it has always been.

The history of human progress is just beginning. Engineers, Dr. Millikan pointed out at the Anniversary Dinner in Washington, look at the curve of life macroscopically, not microscopically, and find that its trend is ever upward; and in international relations Mr. Hoover said on the same occasion that the great inventions and discoveries had multiplied the problems of government and that the perplexity of these problems progressed constantly with the increase of our population, so that a large leavening of engineering knowledge and the engineering attitude of mind and the engineering method would be necessary for their solution. Dr. Conrad Matschoss showed how national boundaries do not exist for the channels through which flows the constructive spirit of engineering progress. This and other testimony bear out the conviction that, like St. John on Patmos, the engineer sees a "new heaven and a new earth," and expresses the spirit of his philosophy in the courageous and optimistic conviction inscribed on the Fiftieth Anniversary Medal, "What is not yet, may be."

This keynote of progressive optimism which is the spirit of engineering was successfully established during the Fiftieth Anniversary Celebration of The American Society of Mechanical



CHARLES T. MAIN

CHARLES E. GORTON

Engineers, and an international atmosphere was maintained throughout all of its events because of the presence of distinguished delegates and guests from outside of the United States, and the reports which were read of conditions in their countries. The anniversary was memorable on account of the dominance of this spirit and its international atmosphere, and because of the historical significance of the exercises in New York and in Hoboken. The presence of distinguished foreigners, of the chief diplomatic officers of the countries represented by the medalists, of President and Mrs. Hoover and their party at the Anniversary Dinner, was a sincere compliment to the prestige of the Society. As an occasion for the conferring of honors and awards, the auspices were favorable and unique. The opportunity that was afforded of meeting friends and distinguished strangers was unusually profitable.

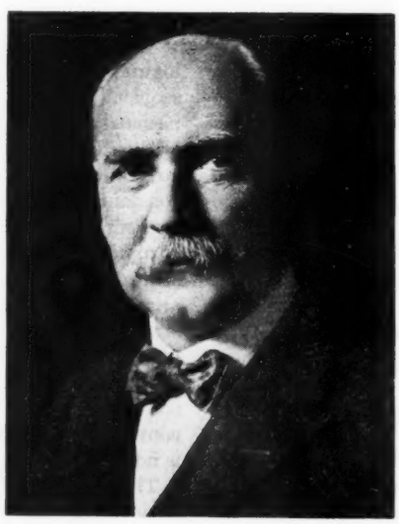
No words can adequately express the high quality of the many memorable events such as the unveiling of the memorial tablet at the Engineering Societies Building on Saturday morning, followed by the pilgrimage to the present offices of the *American Machinist*, under whose skilful guidance the founders of the A.S.M.E. brought about the preliminary meeting in 1880; the unique pageant at Stevens Institute; the welcoming dinner in New York; the services at the Cathedral of St. John the Divine on Sunday; the welcoming assembly in Washington on Monday morning, where delegates from the entire civilized world presented beautifully engrossed greetings; the presentation of monographs on the effects of engineering on civilization, made on Monday afternoon, and summarized then and on Tuesday morning in appropriate addresses by as many of their authors as were present; the reception on Monday night by the Officers and Council of the Society, at which Colonel and Mrs. Paul Doty, and Mr. and Mrs. William Elmer represented President and Mrs. Piez; the founders' luncheon on Tuesday noon, at which medals were presented to the six living founder members, John W. Cloud, of London, England, John S. Coon, of Atlanta, Ga., Robert F. Grimshaw and Francis H. Richards of New York, E. H. Robbins, of Pittsfield, Mass., and Ambrose Swasey, of Cleveland, Ohio; the convocation for the conferring of honors, with the presentation of Fiftieth Anniversary Medals to sixteen distinguished engineers of Austria, Belgium, Canada, Colombia, Czechoslovakia, France, Germany, Great Britain, Italy, Japan, Mexico, The Netherlands, Sweden, Switzerland, Uruguay, and the United States, and of other medals to certain engineers of this country; and finally of the perfect Anniversary Dinner, honored by the presence of President and Mrs. Hoover, at which the Hoover Gold Medal was instituted and presented to the chief magistrate of the nation with exercises distinguished by the grace and dignity of those who took part in them.

The only regrettable feature of the Anniversary was the absence, due to illness, of President Piez, whose greetings, read at the Anniversary Dinner, will be found elsewhere, and of other distinguished engineers who had been designated as medalists; Senator Luigi Luiggi, of Italy, who had made a special trip to this country for the occasion but was forced to remain in New York because of illness; Ludwig Erhard and Aurel Stodola, of Austria and Switzerland, respectively, who were prevented by ill health from leaving Europe; Donato Gaminara, of Uruguay, unavoidably detained; and four of the six living founders, Messrs. Cloud, Coon, Richards, and Robbins.

UNVEILING THE TABLET

Another account of the Fiftieth Anniversary, to be found in the April 22 issue of the *A.S.M.E. News*, records in greater detail than is appropriate in this more interpretative treatment the many interesting events of the celebration.

The historical aspect of the celebration was the feature of the New York and Hoboken exercises. The unveiling of the bronze tablet shown opposite page 509 marked the initial ceremony. In the absence of President Piez, Charles E. Gorton, of New York, vice-president of the A.S.M.E., conducted the exercises

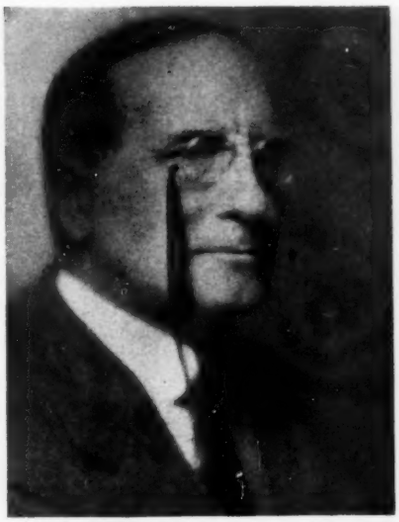


FRANCIS LEE STUART

ROBERT L. DAUGHERTY

before a group of members and guests which filled the lobby of the Engineering Societies Building, where the tablet is located, and introduced Charles T. Main, of Boston, past-president of the Society, who made the address of presentation.

Mr. Main reviewed briefly the history of the Society and the purposes enunciated by Alexander Lyman Holley at the preliminary meeting of February 16, 1880. He showed how these principles had been carried out during the first twenty years, during which the Society grew in membership and its importance and usefulness became manifest. With the gift, by Andrew Carnegie, of funds to construct homes for the engineering societies and the Engineers' Club, he said, a second period of growth commenced. He spoke also of the services to engineering which the Society had rendered during the past fifty years in the work of its committees, in its meetings and publications, and in its contacts with the engineer individually and through cooperating organizations, other engineering societies, and governmental agencies.



GEORGE PIERCE BAKER

HARVEY N. DAVIS

In speaking of the tablet, he said: "It stands not alone, however, as a memorial to men and the visible achievements of men, but it stands as a memorial to the spiritual ideals of the concrete result possible. And now it appears that the outlook for future achievement is brighter than ever, and it is hoped and expected that our Society and other engineering societies will cooperate in placing and keeping the profession on the high plane of which it is worthy."

The tablet was unveiled by John Sweet, of Syracuse, N. Y., a grandnephew of John E. Sweet, founder, honorary member in perpetuity, and past-president of the Society. It was accepted in the name of Engineering Foundation, Inc. (formerly the United Engineering Society), administrator of the Engineering Societies Building, by Francis Lee Stuart, president of the Foundation.

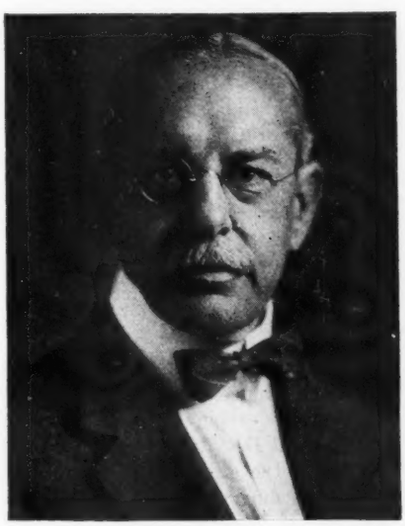
"AMERICAN MACHINIST" AS HOST AGAIN

Acting once more, after fifty years, as host to the mechanical engineers, the *American Machinist* invited the Society and its guests to the offices of the McGraw-Hill Publishing Company. Here Kenneth Condit, the present editor, introduced Malcolm Muir, president of the McGraw-Hill Publishing Company, who gave an address of welcome. He reviewed the incidents prior to the formation of the Society in which the *American Machinist* had played such an important part. His address was followed by the presentation of a one-act play, as noted in the *A.S.M.E. News* of April 22, which depicted the developments in the offices of the *American Machinist* fifty years ago leading up to that famous dinner at which a harmonious agreement was reached on the desirability of forming an association of mechanical engineers. The luncheon which followed the play afforded an opportunity for the renewal of friendships and associations that was greatly appreciated.

THE PAGEANT

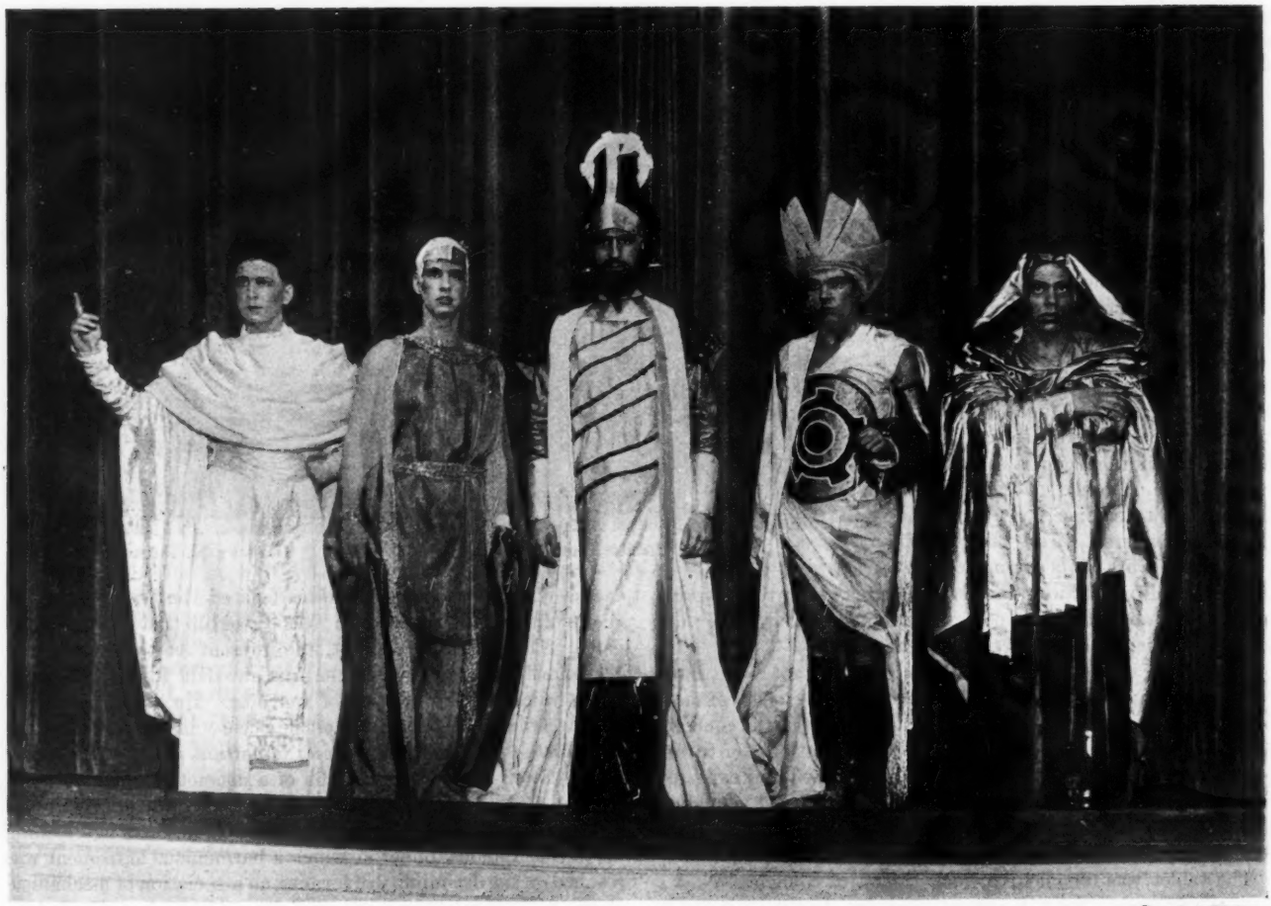
The brilliantly conceived and splendidly executed pageant "Control," which was presented at Stevens Institute Saturday afternoon and which was such a highly praised feature of the Anniversary, places the Society everlastingly in debt to its author, Prof. George Pierce Baker, of Yale University, to the trustees and officers of Stevens Institute, and to the undergraduates of the Institute who were actors in it. Professor Baker achieved something significant and extraordinary in portraying the struggle of man for control over his environment through the medium of modern theatrical devices and the ageless art of the drama, combined by him with soul-stirring effect. President Davis and his associates and the trustees of the Institute fully lived up to the tradition of their great first president Henry Morton, who acted as host to the organization meeting of the A.S.M.E. on April 7, 1880, and spared neither pains nor expense to make the occasion a memorable one.

The undergraduate acting was warmly applauded at the three performances which it was necessary to stage in order to accommodate the great number who wished



WILLIAM ELMER

MALCOLM MUIR



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FROM THE PAGEANT: INTELLIGENCE, IMAGINATION, MATURE CONTROL, CONVERSION, AND FINANCE

to see the pageant. These young men have earned a distinction in engineering history which they will prize more highly as time goes on. If their participation in this unusual event has quickened their understanding, stimulated their imagination, and made more steadfast their purposes—effects that older men, in viewing the pageant felt so keenly—then fortunate indeed are they in having had such an experience at the beginning of their careers. With youth, ambition, and zeal as their aids, and with life bright before them, they have yet the possibility of giving substance to the dreams of the present generation of engineers, and of accomplishing the high purposes so hopefully expressed during this celebration.

A few pictures of scenes from the pageant are shown in this issue. Others will be found in the April 22 issue of the *A.S.M.E. News*, which also contains a description of the scenes and the names of the actors. In explanation of certain features of the pageant, Professor Baker has written:

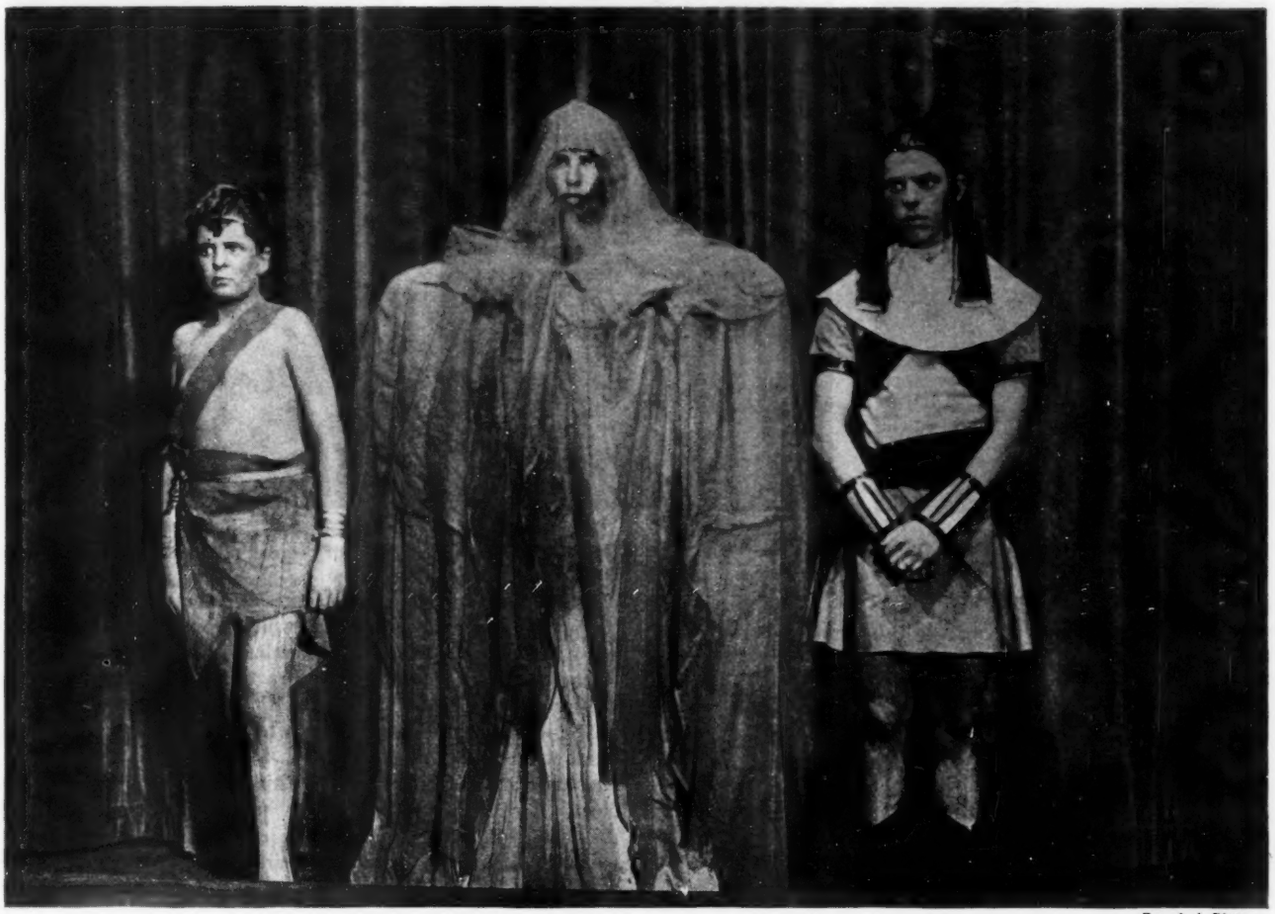
This pageant, "Control," written specially for the Fiftieth Anniversary of The American Society of Mechanical Engineers, is, from the very conditions under which it must be produced, somewhat unusual. Ordinarily a pageant is an outdoor performance in daylight or electrically lighted at night, as may be easier and more artistic, given by a mixed group and lasting at least two hours. Because the original meeting of the Society took place in the auditorium of Stevens Institute of Technology, this hall has seemed to be the best place in which to act it. The size of the stage precludes the use of any very large number of actors. The fact that it must be given by students of the Institute practically forbids a mixed cast. Other arrangements for the entertainment of the visiting engineers have made it requisite that the pageant should last only a little over an hour, to be repeated twice at later hours on the same day. Obviously, much of the material which should be shown in illustration of the remarkable development of mechanical engineering in the past fifty years, and the growing sense in such work that beauty may and must be combined with utility and power, have demanded the use of the motion picture instead of tableaux. It has also made necessary symbolic figures to bind the parts together. Inasmuch as the pageant celebrates the increasing triumphs of the mechanical engineer, it has seemed wiser to do without a band or orchestra, and to substitute electrical reproduction. The requisites for the pageant have been, then, to make it brief, to confine it to a small number of actors, and to make it illustrate clearly the development of mechanical engineering in the past fifty years in as varied a way as possible.

In the historical scenes the author of the pageant has striven to correlate details which happened or may have happened. As far as possible the dialogue repeats, or approximates, words of the speakers as reported in letters, anecdotes, etc. For instance the Watt Scene is built up from historical details; that as to George Stephenson is a greatly abbreviated re-presentation of speeches reported from his examination for some three days or more before the House of Parliament.

THE WELCOMING DINNER

Charles M. Schwab, past-president of the A.S.M.E., acted as toastmaster at the Welcoming Dinner in New York, held at the Hotel Roosevelt on Saturday evening. The address of welcome was delivered by Col. Paul Doty, vice-president of the Society, who graciously extended the greetings of the Society to all of its honored guests and members. The speakers at the dinner were Edward J. Mehren and Robert I. Rees.

Edward J. Mehren, vice-president of the McGraw-Hill Pub-



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FROM THE PAGEANT: CHILD CONTROL, MYSTERY, AND CURIOSITY

P and A Photo

FROM THE PAGEANT: REPRODUCTION OF THE ORGANIZATION MEETING AT WHICH THE A.S.M.E. WAS FOUNDED. HENRY R. WORTHINGTON IS THE CHAIRMAN, LYCAURGUS B. MOORE IS THE SECRETARY

EDWARD J. MEHREN

CHARLES M. SCHWAB

ROBERT I. REES

lishing Company, New York City, offered the felicitations of the engineering press, saying "well done" on its behalf and wishing the Society Godspeed for the future. The engineering press, he pointed out, as a "friendly critic" of the Society, was an appropriate agency for making such felicitations, since its close connection with the Society's development gave weight to its words.

Mr. Mehren's address dealt with cardinal features of the Society's history which had affected it not only during the past but which would continue to affect its progress and purposes in the future. The first of these features was the rapidity of change in engineering, and the second, the special character of the social contribution of the mechanical engineer. The steady increase in the rapidity of engineering progress he considered to be very striking.

However rapid had been the acceleration of engineering development and progress, he said, it was sure to continue, the curve representing it being parabolic in shape. The causes which underlay this acceleration, he pointed out, were, first, our production of surplus wealth, and, second, the optional purchasing power of the public. Elaborating these ideas somewhat, he showed that while engineers had accepted change and progress as theories, inasmuch as they were part and parcel of the modern era, their acceptance of change had been passive. They had not accepted it as a cardinal element in policy; they had not sensed its compelling character. The pace of the engineer in the march of progress had been set largely by outside forces, he said, such as salesmen, the executive, and the public. "If we are to play the role that should properly be ours," he continued, "we must accept rapid change as a principle in our planning. Most important, too, is the need for vision, that the engineer may be able to sense the direction in which demand is surely headed, so that by study, experiment, and research he may anticipate the demand and be ready to serve it when the public, becoming conscious of its need, begins to call for new goods in the market place."

The second feature of the past fifty years to which Mr. Mehren directed attention was the special contribution which the mechanical engineer had made to human welfare. While others had idealized and theorized, he said, the engineer had gone steadily to work, winning the battle that the idealists dreamed but had not had the ability to carry on and to win. "Without any fuss," to quote Mr. Mehren directly, "his work has changed unsanitary to sanitary factories, reduced industrial accidents and occupational diseases, brightened up shops, eased the load of physical labor, and, by raising wages and shortening hours, sent the worker out into the sunshine with money in his pocket to enjoy his leisure. Not credited with idealism is the engineer—yet he has made idealism real. Practical to the last degree, he has nevertheless erected a physical throne for spiritual man."

The mechanical engineer, said Mr. Mehren, had affected material progress by his contribution in devising new, ingenious, high-capacity machinery, and by his specialization in management. To this latter contribution he paid high tribute, saying that "no single agency in the world has done so much for human advancement in the last thirty years, no group has placed the world under so profound obligation to it for physical benefits, no body has affected so signally the welfare of the worker as have the members of this Society."

Admitting that repetitive work, for which engineers are blamed, did exist and probably always would, Mr. Mehren protested that it had always existed and that many persons could not rise above this line of endeavor. Engineering, however, had increased the wages and leisure of this kind of labor. He attacked the theory that wealth necessarily implied decay, and asserted that "if character be strong, the possession of wealth does not result in moral decay; wealth is then rightly evaluated as a means and is wisely employed. If character development has not kept pace with wealth creation, it is the fault of the lay and religious teachers who must often bring the change." As for unemployment, cyclical, seasonal, technological, this was a problem, he believed, which would be solved as the problems of accident prevention were being solved, in our own way, and without resorting to European models.

ADDRESS BY ROBERT I. REES

Robert I. Rees, president of the Society for the Promotion of Engineering Education, spoke on behalf of the educational institutions of the country. He reviewed briefly the progress of engineering and science from the time of primitive man to the present day, and showed how this served as the background for the development of engineering education. He then touched upon some ideals in this branch of instruction as stated by Prof. Wm. H. Burr of Columbia University in 1893, and said that today we could still endorse them. Courses in engineering had been set up, and the work had been aided by the engineering societies. The courses, he said, had passed through many stages of development, beginning with a concern for fundamentals, digressing,

with the increase of diversified manufacturing processes, into specialized applications, and returning more recently to the basis of the physical and mathematical sciences. During this time, he pointed out, the importance of the economic and administrative aspects of engineering had been reflected in curricula, and cultural subjects had become more common.

Passing to industry's need for graduate engineers, Colonel Rees showed that college-trained men at present were available for a quarter only of the present annual requirements. Inasmuch as registration in engineering schools was increasing at a lower rate than in arts and business colleges, he said, the percentage of engineers to other graduates would inevitably be further reduced. It was imperative in his opinion that more, rather than less, engineering and scientific knowledge should be devoted to the continuance and growth of national prosperity.

The problem of selecting suitable young men for an engineering career gave him concern. He stated that industry and the national engineering societies must give attention to the rewards which the profession might offer, so as to make certain that they were favorably comparable with rewards in other professional fields. On the other hand, he said, the colleges must concentrate on individual aptitudes and selective processes, provide a sound curriculum of fundamentals, and trust to industry for further specialization.

Colonel Rees concluded by saying that we must recognize the following:

That, with the youth of the country, our profession does not enjoy a popularity commensurate with the material and intellectural rewards of which both the education and practice are inherently capable;

That our whole system of secondary-school and junior-college education contains only fragmentally influences leading to an appreciation of the engineering profession;

That educational and vocational guidance which is now being developed is largely controlled by students of psychology, almost none of whom have the educational background or experience to appreciate the cultural and intellectual as well as the practical value of engineering education;

That the teachers of our technical schools are underpaid, and if the condition continues, the future leadership which the teaching profession needs will not be found in it but in other fields of endeavor;

That engineering education is expensive and money must be forthcoming for our state and privately endowed institutions, which will enable them not only to pay adequate salaries, but to be properly equipped with facilities and funds that will enable them to perform their proper function in the field of scientific research;

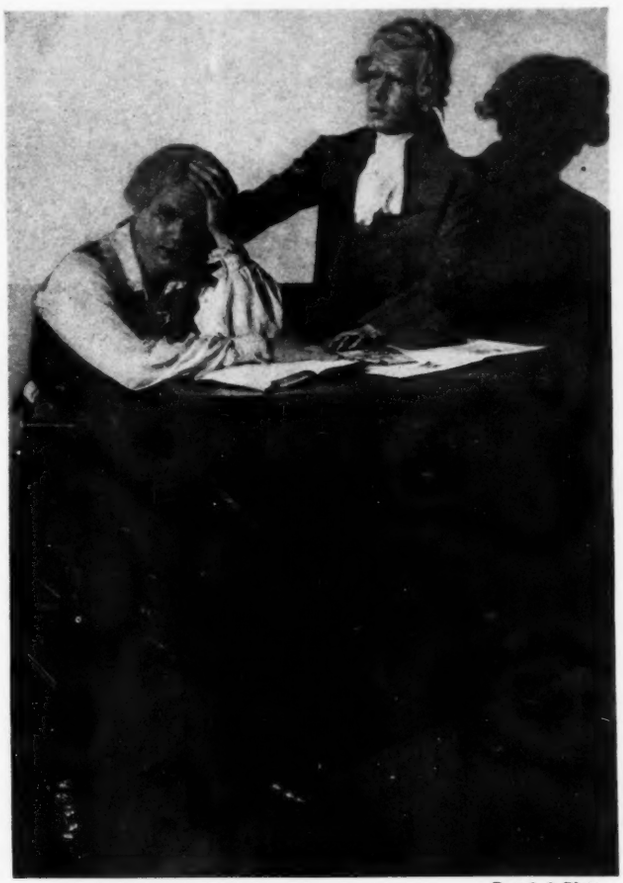
That the contributions of the engineer in business have not been properly recognized, and industry must provide greater social and financial rewards for future efforts.

To all of these problems I direct your attention. The investigation which the Society for the Promotion of Engineering Education has just completed is the first step in a united effort. Much good has come out of it in clarified objectives, improved curricula, and better teaching. Increasing benefits will be derived from it.

The American Society of Mechanical Engineers and other National Engineering Societies, together with the S.P.E.E., can contribute much in a cooperative effort to meet the challenge of engineering education and practice. The American Society of Mechanical Engineers has recognized its responsibility in generously supporting the summer schools for engineering teachers, and through its Committee on Economic Status has outlined a program which will contribute to the solution of some of the problems mentioned. Particularly are the members to be commended for their efforts in encouraging the continuing intellectual development of young engineers, and in raising to further high standards the profession of engineering. Such cooperation fortifies our brother-members in engineering education in the discharge of the sacred trust which is their inheritance—a trust which, in the development of the young manhood of the nation, guarantees leadership which will make sure the foundations of our American civilization.

The Setting at Washington

The setting of the session in Washington was singularly impressive, and the quiet dignity of the National Council Chamber of the United States Chamber of Commerce was appropriate to the occasion. Hung with the banners of those sixteenth- and seventeenth-century explorers who dared the terrors of unknown seas to extend the domains of their sovereign princes in a new world, this great room was charged with the spirit of adventurous and courageous discovery. What could have been more symbolic to an engineering gathering than the device of that seeker for the fountain of eternal youth, Ponce de Leon? For here were represented those who had brought a new and eternal youth to mankind by placing the burdens that make men old on the shoulders of power-driven machinery, and who were showing the way to new adventures of the spirit to a



P and A Photo

FROM THE PAGEANT: MATTHEW BOULTON ENCOURAGING JAMES WATT

world whose physical needs had found at least the elements of satisfaction. Or what more appropriate than the emblem of Cortez, whose startled eyes first glimpsed the Pacific, to men whose researches are continuously bringing them to new peaks from which to view the hitherto unknown? The modern La Salles, penetrating for the first time the fertile valleys of an unexplored continent of human endeavor, are like him imbued with the spirit of progress that presses beyond the frontiers of life as it now is, as they sit beneath his emblem and listen to the testimony of their accomplishments in the ordering of human affairs.

The Welcoming Session

Gathered at this inspiring scene the delegates and guests met for the Welcoming Assembly. Representing the absent president of the Society, Mr. Charles Piez, were six vice-presidents,

with Ralph E. Flanders presiding. Mr. Flanders called attention to the significance of the occasion in his welcoming address. He expressed the regret, felt by every one, that Mr. Piez' illness prevented his performance of the functions of presiding officer. He also requested the audience to stand with bowed heads in memory of William Howard Taft, recently deceased.

"Above all," he said, "do we desire to take the full measure of our responsibilities and of our opportunities. Not all that has been done has worked toward the common welfare. Some fraction of it has been clearly harmful. More has carried mingled weight of bane and blessing. Of a still greater part do we feel that it holds a rich content of human values, but mostly unrealized and unappreciated.

THE MAYFLOWER HOTEL, A.S.M.E. HEADQUARTERS IN WASHINGTON

"In these profitable exercises of gratitude, remembrance, recognition, self-analysis, and dedication we would not stand alone. We could not if we would. Our profession overflows all bounds. Engineering is a vast cooperative enterprise, confined by no rigid walls of narrow specialization.

"Our profession, furthermore," he continued, "takes no account of race, religion, or political belief, nor of the natural boundaries of snow-clad mountains and stormy seas. To the common storehouse of research, practice, and experience from which each of us draws, all have brought their gifts. The old countries and the new, the nations small in numbers and those with spreading empires—all alike serve the cause of engineering truth and are necessary to its progress."

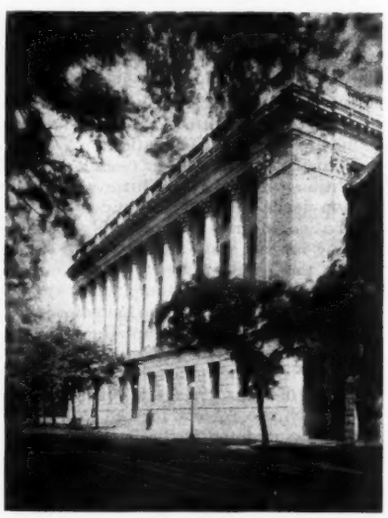
He then addressed special words of greeting to the delegates to the celebration, to the engineering societies, from whose practice and traditions so much had been derived; to the visitor from outside of the United States, without whom the international aspect of the ceremony would be lost; to the men of business and finance who were contributing their imagination and resources; to the scientists from whence came engineering; and to educators who were expanding the body of engineering knowledge.

The session was then turned over to Secretary Calvin W. Rice, who called the roll of the delegates to the Anniversary Celebration and received from them the engrossed greetings which they bore from the institutions that they represented. Brief addresses were delivered, a delegate from each country represented having previously been designated to perform this function. The roster of distinguished names of individuals and of institutions was impressive, and those who rose in the roll call were loudly applauded and viewed with the interest that attaches to well-known names.

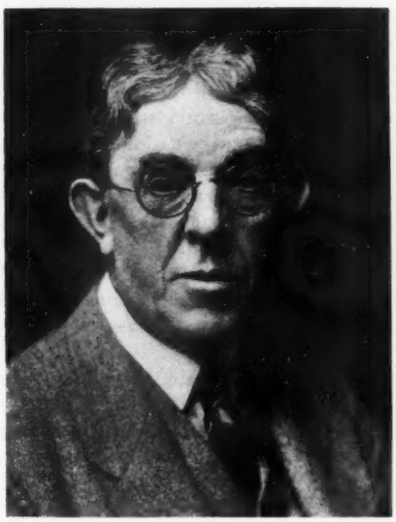
Greetings from the engineering organizations in the United States were offered by Francis Lee Stuart, speaking for the absent president of the American Society of Civil Engineers. John F. Coleman; William H. Bassett, president of the American Institute of Mining and Metallurgical Engineers; and Harold B. Smith, president of the American Institute of Electrical Engineers. Palmer C. Ricketts, president of Rensselaer Polytechnic Institute, spoke for the engineering colleges of the United States, Admiral David W. Taylor for the scientific and professional societies (in the absence of Major-General George O. Squier), and William Butterworth, president of the United States Chamber of Commerce, for the business organizations of the United States.

HUMANISTIC ASPECTS OF ENGINEERING

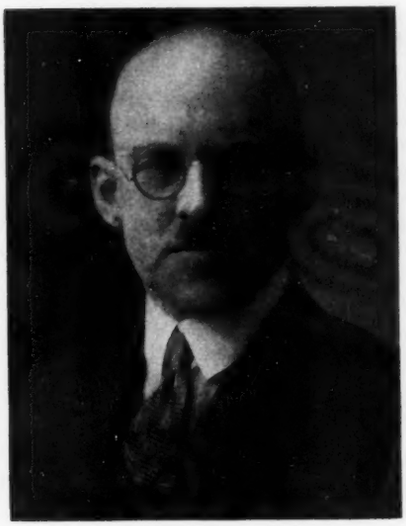
It is not an easy task to summarize that impressive group of sixteen monographs covering the social and economic effects of engineering upon the lives of the people represented by the distinguished engineers who had been chosen as the medalists of the Anniversary. Throughout two entire sessions, on Monday afternoon and Tuesday morning, testimony was given to these effects. As one speaker after another had finished, an impression was gained of the singularly important influence which physical environment and geographical condition have had on the development of economic and industrial life. The exploitation of certain natural resources to make up for the lack of others has stimulated engineers in these countries in making improvements in machinery and methods. Countries poor in raw materials have advanced industrially, their trained mechanics, by means of skill and machinery, converting the raw products of foreign mines and fields into valuable commodities eagerly sought for in the markets of the world. The fortunes of war and political dynasties, robbing some nations of the control of important resources, have spurred engineers to develop less valuable deposits of raw materials and to discover substitutes. Engineering skill has been called upon to counteract the inherent weaknesses of some nations by perfecting methods of defense. Countries located at the crossing of trade and immigration routes, or at the natural battle grounds of rival races, have testified to problems of existence which arise as a consequence of such location. Torrid and frigid climates, moist and arid atmospheres, steep mountains, forbidding seacoasts, seismic dangers, unnavigable rivers, impenetrable forests, vast areas of unexplored and undeveloped land, congestedly populated areas, are some of the contrasts brought out. There is testimony from Italy where engineering works of a magnitude yet unsurpassed are centuries old; from Western Europe where boundaries have shifted and governments have changed; from Japan where a dynasty and a culture are more ancient than much of western civilization, but where the industrial revolution came one hundred years late; and from certain sections of



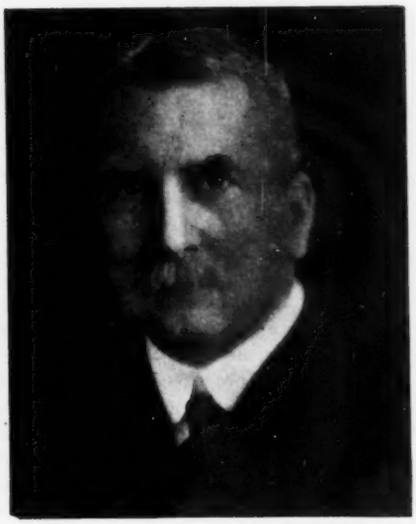
U. S. CHAMBER OF COMMERCE, WHERE SESSIONS WERE HELD



PALMER C. RICKETTS



RALPH E. FLANDERS



D. W. TAYLOR

South America where the engineering problems are as yet those of winning the land from the wilderness.

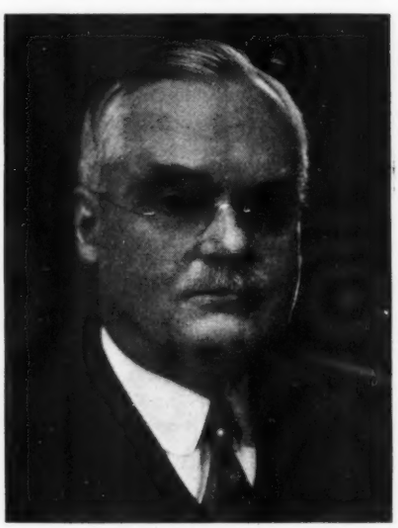
Charles E. Gorton, vice-president of the A.S.M.E., acted as chairman at the first session for the presentation of the summarizing addresses. He said that it was the desire of the A.S.M.E. that the friendly relations of the engineering profession throughout the world be brought to light, especially in the social, industrial, and administrative circles everywhere, so that the true character, not only of the engineer, but of the nations as well might be better understood. We must not forget, he said, that history clearly indicated that progress can only be attained by degrees, and that improvement must be sought by elevating all to a general level. Stating that the tremendous advancements made in comforts and happiness during the past few years have been largely the result of engineering skill, he asserted that the purpose of the Anniversary was not so much to place on record the achievements of the past as it was to point the way to future development.

THE SUMMARIZING ADDRESSES

The Austrian monograph was edited by Hofrat Ing. Ludwig Erhard, director, Technical Museum, Vienna, and president of the Oesterreichischer Verein deutscher Ingenieure. The co-editors were Prof. Ing. Josef Fuglewicz, mining, Prof. Dr. Ing. Othmar Keil-Eichenthurn, foundry, General Direktor Ing. Friedrich Brock, power management, Sektionschef Ing. Bruno Enderes, communication, Oberbaurat Ing. Ernst Stelzer, technology, and Sektionschef Ing. Otto Kunze, technical institutions.

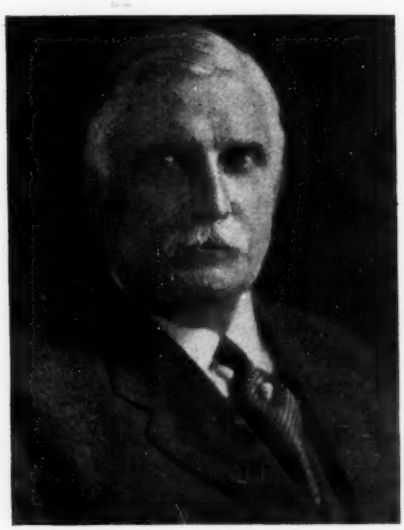
Ing. Dr. Adolf Giesl-Gieslingen made the summarizing address. He showed how Austria, cut to one-eighth of her former size following the World War, was being returned to a position of prominence by engineers. They had developed deposits of low-grade lignite partially to replace lost coal fields, and were electrifying the railroads in order to reduce the importation of coal. Agriculture was being intensified, he said, and labor-saving devices were being introduced so that many people might be fed from the products of a greatly diminished farming area.

The Belgian monograph was prepared by a group consisting of The Honorable Georges Theunis, Minister of State, Dr. Edouard Gosselin, professor of physics at the Military School of Belgium, Prof. Edouard W. Bogaert, University of Brussels, and Chief Engineer of the Marine, Prof. Gommaire Von Engelen, Uni-



HAROLD B. SMITH

WILLIAM H. BASSETT



WILLIAM BUTTERWORTH

versity of Ghent, Prof. Chas. Hanocq, University of Liége, Prof. Gustave Gillon, University of Louvain, and Prof. René Bradfer, School of Mines and Metallurgy at Mons.

The summarizing address was presented by Dr. Albert De Smaele. He emphasized some of the social progress which Belgian workmen had made. Wage earners in Belgium, he said, were paid a premium if they were fathers of large families. Industrial laborers had won political importance and social improvements, higher wages, insurances for accident, illness, and old age; safety and health control in mines, factories, and railroads, and compulsory education. He added that they had obtained an eight-hour bill, a temperance system similar to that of Quebec, and that they were now fighting for vacations with pay. He then listed some examples of Belgium's contribution to the technical progress of the world during the past fifty years, and ended with a tribute to President Hoover for his services to Belgium during the War.

The Canadian monograph was presented in abstract by its author, Brigadier-General Charles H. Mitchell, Dean, Faculty of Applied Science and Engineering, University of Toronto and Past-President, Engineering Institute of Canada. Agriculture, he said, was the Dominion's first industry. The great growth of Canada he attributed largely to the development of water power, and he was looking forward to further expansion from the projected developments on the St. Lawrence River. The value of the transcontinental western railway enterprise in molding and developing Canada was hard for him to appraise. He considered the significant feature of agriculture in Canada today to be the rapid change coming over the industry by mechanized farm equipment. This turning point, he said, meant the reentry of the mechanical engineer in a new and much larger way.

Ing. Dr. h. c. E. Zimmler, President, Masaryk Academy of Work, contributed the Czechoslovakian monograph, and Dr. Joseph Schneider presented the address summarizing it. Dr. Schneider called attention to the fact that the first engineering school, established in 1717, the first mining school, and the first school for studying brewing were Czechoslovakian contributions, and that the first European railway was built in Czechoslovakia. The country, he said, had also pioneered in industrial management, and had at Prague a special English technical library named in honor of President Hoover. Up to now, he said, the hand production of glass, ceramics, and textiles had restricted machine manufacture, but at the same time it had elevated the standard of manual labor and had brought world-wide fame to Czechoslovakia glass and porcelain.

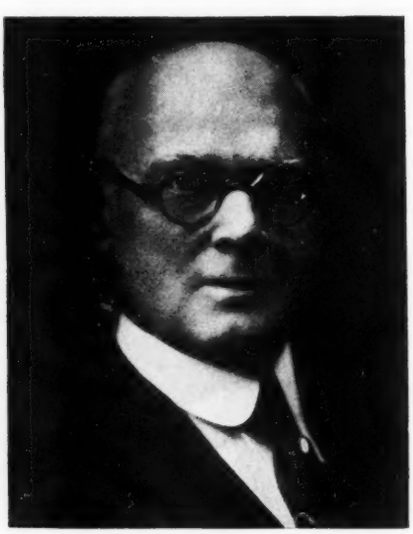
The address summarizing the French monograph was presented by M. Georges Claude, inventor and scientist. This memorial of engineering achievements in France was divided into chapters, each one of which had been edited by an outstanding specialist so that it might be as complete and as exact a document as possible. The authors were M. Schmidt, public works, M. Bréguet, aviation, M. de Fréminville, the automobile, General Ferrié and Professor Blondel, wireless telegraphy, M. Portevin, metallurgy, M. Moteil, motors, Professor Eydoux, hydraulics, M. Parent, mines, Professor Boucherot, electrical engineering, M. Laubeuf, ships, M. d'Arsonval, refrigeration, Professor Matignon, and M. Montier, railways.

Dr. Ing. Conrad Matschoss, director of the Verein deutscher Ingenieure, author of the German monograph, delivered the address summarizing it. He said that in spite of the injurious effects of the so-called machine age, there could be no turning back therefrom. The engineer, he asserted, was optimistic and possessed a belief in the future. He showed how the extension of high-tension transmission lines throughout Europe provided the channels through which the constructive spirit of engineering progress would flow between countries without regard to national boundaries. Thus, he said, the influence of engineering spread into the future. Although there was a time when the saying, "knowledge is power" was on the lips of every one, we know today, he stated, that knowledge unaccompanied by the ability to put it into practice is often no better than a dead weight to carry about. In closing, he said that the nerves of men could not stand the pace of modern civilization; new achievements had not been digested. Salvation would come, he asserted, only by adapting ourselves to the new world around us. It was necessary to awaken in mankind the love for work for its own sake, he said, and we must realize that work in itself counts as one of the greatest moral forces in the world.

The British monograph was summarized in an address by its author, Mr. Loughnan St. L. Pendred, president of the Institution of Mechanical Engineers and editor of *The Engineer* (London). Mr. Pendred stated that the influence of mechanical engineering was not always good in its effect upon home life and its destruction of the home life of the people. It was the engineer's duty, he said, to increase man's comfort and well-being. The monograph concludes as follows:

ARTHUR M. GREENE, JR.

L. P. ALFORD



FRED R. LOW

GROUP OF DISTINGUISHED ANNIVERSARY MEDALISTS WITH THE AMBASSADORS OF THEIR COUNTRIES, AND MR. CONRAD N. LAUER, CHAIRMAN OF THE CONVENTION FOR THE CONFERRING OF HONORS

With this ideal of a new and greater service, another world to conquer lies open before the engineer. He has ministered, and will continue to minister, to the material wants of men, but something far, far greater lies before him. It is not for him, perchance, in his vocation to peer into the "soul of things," but through him the attainment of that glorious abstraction may be made easier. He has brought men together and can bring them closer yet; he can knit the whole world into a single unit; he can remove the frontiers of the land, the sea, and the air, and hasten the coming of a common tongue, common understanding, and a common will to good. With him, and him alone, rests the power to make war or preserve peace. He can decrease labor and increase leisure. He is the great educator. He can take men to see the wonders of the world abroad; he can diffuse great literature; he can bring the voice of great thinkers to the firesides of the humblest. Literature, music, art, and philosophy are in his train.

By removing the hardships of life, he may, under the mercy of Heaven, lead men to the gateways of the Garden of Eden, where mankind, redeemed by him from the curse that he shall live by the sweat of his brow, and in sorrow eat bread, may live a new and greater life. Through him envy, the fruit of most evil, may be removed from a world in which all have sufficient to satisfy their needs. All these things the engineer may do and will do. He is the artificer who shall make the new world of which poets and seers have visions. Before him, a new and glorious ideal of an unheard-of service to humanity is opening. May the great Society, which today we honor, be ceaseless and fruitful in its endeavors to lead and direct mechanical engineering toward that goal; not forgetting the first duty which lies to its hand, the improvement of the art and science of mechanical engineering, may it yet remember that the things of the spirit are greater than those of the flesh.

Prof. Dr. Ing. Luigi Luiggi, Senator, Kingdom of Italy, honorary member of the American Society of Civil Engineers, and member of the Institution of Civil Engineers, was the author of the Italian monograph. Although Senator Luiggi had come to this country especially to present the address summarizing his monograph, he was detained in New York on account of illness and his address was read Tuesday morning by C. E. Davies, A.S.M.E. staff. Senator Luiggi recalled that nearly 4000 hydroelectric plants had already been erected in Italy, a country without coal resources. In Larderello, near Pisa, volcanic steam from crevices was being used for the generation of power. In water works, he called to mind some of the works of engineers of Roman times, and especially the Apulian aqueduct, 1000 miles long. Railroad building, he said, had called for the highest type of engineering skill in Italy because of the natural difficulties encountered in a mountainous country. High-speed automobile roads between important points, he said, were already a fact in Italy. Most of the famous harbors of Italy, he stated, were artificial, having been constructed at great expense. Another natural hazard, that of earthquake, had stimulated the development of anti-seismic buildings.

Dr. Masawo Kamo, head of the department of mechanical engineering, Tokyo Imperial University, president of the Society of Mechanical Engineers of Japan, and honorary member of The American Society of Mechanical Engineers, was the author of the Japanese monograph and made the address summarizing it. Dr. Kamo pointed out that during the past fifty years engineering had accomplished more in Japan than it had in other countries in twice that time. For example, he said, 92 per cent of her dwellings had been wired for electricity, and nearly every home had a radio with which it had recently been possible for dwellers in these far-away islands to hear broadcasting from London. Unbridled streams had, he said, been controlled by means of dams, and their energy had been harnessed to provide electricity for home and factory. Transportation and communication had been established everywhere, bringing into closer contact the distant parts of a scattered island empire. Refrigeration, he said, had made it possible to control the hatching of the silkworms so that it might take place when there was a sufficient supply of mulberry leaves for the worms to live on. While Japan, feeling the effects of the industrialization of civilization later than other countries, had been busily engaged in setting herself abreast of them up to now, he was confident that the research work which was being so extensively prosecuted would soon give it an opportunity to contribute to the development of culture outside its own borders.

The presentation of the monographs covering the humanistic aspects of engineering was continued on Tuesday morning, with William Elmer, vice-president of the A.S.M.E., presiding.

Señor Ing. Norberto Dominguez presented the summarizing address of the Mexican monograph, of which he was the author. After briefly describing the territory in which Mexican engineers carried on their work, Señor Dominguez spoke of its natural resources, the sources of power, the opportunities for technical training, the extractive and converting industries which are so predominant in Mexico, of communication, transportation, sanitation, water sources, and irrigation. In closing he said:

Mexico is still in a transition period, and what the future holds is uncertain. Engineers, not only because of their technical training but in virtue of their broad culture, have played and will continue to play an important role. But it is also necessary that the economic development of the country should enable them to enlarge their field of work in private business enterprises, so that they may be the veritable representatives of the national industry, and in order that in economic questions, both local and international, the

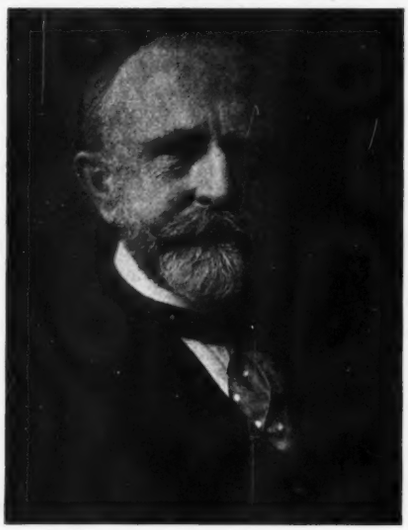
voice of the individual, as well as that of the government, may be heard.

The economic future of Mexico depends on the establishment of a definite stable government; the solution of the labor question; the agrarian problem; the creation of harmony between the social classes; the suppression of communism; and the education of the masses.

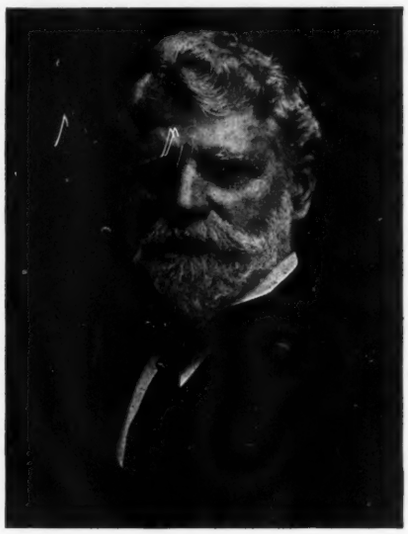
The monograph devoted to engineering in The Netherlands was written by Prof. Ir. Daniel Dresden, president of the Jaffa Engine Works, who also presented the address summarizing it.

He recalled that the very existence of this country depended upon the bridling of the ocean by engineering works, and that the cooperation of the civil engineers who built the dikes and the mechanical engineers who made the pumping plants and provided the driving power was required to safeguard the homes of the people.

In addition, he said, engineering had improved waterways and ports had been equipped with powerful cranes and adapted to the largest vessels. The new locks for Amsterdam, he said, were larger than those of the Panama Canal. Land traffic, he showed, had been handicapped by the great number of waterways and had given rise to the development of special types of movable bridges. Ship and engine building had also been stimulated. As it was an agricultural country, irrigation and drainage were important necessities, and refrigeration had been greatly developed to preserve dairy and other products. Electricity, he said, was within reach of approximately 80 per cent of the population.



JOHN R. FREEMAN



AMBROSE SWASEY

Vilhelm Nordström, manager of the De Laval Steam Turbine Company, Sweden, delivered the address summarizing the monograph from the Scandinavian countries. Mr. Nordström's collaborators in writing the monograph were Ing. Povl Vindig, past-president, Danish Engineering Society, Denmark, Ing. Prof. B. Wuolle, professor of industrial economy, Technical University of Helsingfors, Finland, and Ing. Reidar Lund, consulting engineer, Norway.

Mr. Nordström said that Europe's purest iron ore and a type of worker developed throughout many generations had made Sweden's iron and steel industry famous. The model agriculture of Europe, he pointed out, had been developed in Denmark largely as a result of technical advance devoted to improving farm machinery and operation. Finland, he said, exported lumber products, some of which came to the United States, and Norway's waterfalls made her electrochemical industries famous.

The Colombian monograph was written by Prof. Julio Nieto, chief engineer for the Ministry of Foreign Affairs, who presented it in abstract. Professor Nieto described briefly the geographical conditions which affect the engineering works in his country. He divided his monograph into three sections, devoted to roads, municipal engineering, and industrial engineering. He gave statistics covering the highways, railroads, waterways, and aerial services in Colombia. Municipal engineering was developing, he said, although public services were, as a rule, very poor. Electric light and power service was to be found in most important towns, and sewerage and pavement systems were under way. Industrial conditions, he said, were as yet just beginning their development, but with abundant water power and great natural resources as yet untouched, engineering was destined to occupy an important place in national life.

The monograph on engineering in the southern countries of South America was written by Prof. Domata Gaminara, of Uraguay. The address summarizing it was delivered by Dr. L. S. Rowe, director-general of the Pan-American Union, Washington, D. C. Professor Gaminara wrote that prior, to 1880, the engineer had played but an insignificant part in South America. Up to the present century, engineering projects had been carried out under concessions or franchises usually granted to Europeans. These foreign engineers had made but brief stays in the country and their contacts with the cultural, political, and economic development had been slight. However, after 1900, when the technical schools of the country had begun to graduate engineers, engineering began to play an active role. At the present time, he asserted, most of the engineering work was conceived and carried on by native engineers. Today in South America, he said, engineers were serving as presidents of republics, as presidents of universities, and as members of congresses.

The chief editor of the Swiss monograph was Prof. Dr. Aurel Stodola, Grashof Medalist of the Verein deutscher Ingenieure. The collaborators in preparing the monograph were Prof. Dr. B. Bauer, electrotechnology, Prof. Dr. E. Böhler, political economy, Dr. h. c. E. Huber-Stockav, railways, Prof. E. Meyer-Peter, hydraulics, and Prof. Dr. W. Wyssling, power development. Henri Naville, of Brown-Boveri, presented the summarizing address. He said that engineering had made little hemmed-in Switzerland one of the most advanced countries in the world. There were nearly 2000 miles of electrified railway in Switzerland, he said. Electric power, he pointed out, was supplied to 98 per cent of the inhabitants of the country, and 1100 million surplus kilowatt-hours were exported annually. In his opinion, Swiss manufacturers were leaders in many fields of machine design.

For the United States, Dr. Carl E. Grunsky, consulting engineer, president of the American Engineering Council and past-president of the American Society of Civil Engineers, delivered an address in which he summarized the monograph which he had written on the influences of engineering in this country. Following Dr. Grunsky, Dr. Fred R. Low, past-president of the A.S.M.E. and editor-emeritus of *Power*, presented "A Half-

Century of Progress in Mechanical Engineering in the United States," a group of reports prepared by the Professional Divisions of the A.S.M.E. and their representatives. These reports were the major feature of the Anniversary (April) issue of MECHANICAL ENGINEERING.

THE FOUNDERS' LUNCHEON

On Tuesday noon, at the Mayflower Hotel, a luncheon was served at which the six living founder members of the Society were presented with special medals. These medals were identical with those presented to the authors of the monographs except that the inscription on the obverse had been changed to make the medal appropriate to the occasion. Mr. John R. Freeman, past-president of the Society, acted as chairman of the ceremonies of presentation, and Prof. Robert L. Daugherty, vice-president, presented the medals and the certificates which accompanied them. Of the six living founder members, Mr. Ambrose Swasey and Mr. Robert Grimshaw were the only ones at the luncheon. Mr. Swasey and Mr. Grimshaw made brief addresses in response to the applause that greeted them when the medals were awarded.

The medals awarded to the other four were received in their absence by well-known members of the Society, Mr. Edward N. Trump representing Mr. John S. Coon, Mr. George Bond representing Mr. Francis H. Richards, Prof. Wm. T. Magruder representing Mr. John W. Cloud, and Dean R. L. Sackett representing Mr. Eugene H. Robbins.

THE CONFERRING OF HONORS

The most impressive session of the Fiftieth Anniversary Celebration was the convocation for the conferring of honors held on Tuesday afternoon in the National Council Chamber of the U. S. Chamber of Commerce Building. These exercises were made memorable not only because of the distinguished engineers who were to receive the awards, but also because of the fact that the chief diplomatic officer of each country presented to the Society for the conferring of the Fiftieth Anniversary Medal the engineer selected for this honor by the engineering profession of his country.

The marshals for the occasion, dressed in academic costume, escorted the medalists and the ambassadors from the reception room at the right of the stage to seats in the front of the room. The marshals were the members of the Society's committee on awards: Kenneth H. Condit, Arthur M. Greene, Jr., Herbert L. Seward, and Roy V. Wright. On the stage were Conrad N. Lauer, vice-president of the Society, who acted as chairman and presented the medals, Dr. Wm. F. Durand, president, Guggenheim Medal Board, L. P. Alford, chairman of the Gantt Medal Board, and C. E. Davies, assistant secretary of the Society.

The Fiftieth Anniversary medals were presented first. The ambassador or other diplomatic officer of the country represented by the medalist, and the medalist were escorted to the platform by the marshals, the ambassador approaching from the right of Mr. Lauer and the medalist from his left. The ambassador was then presented to Mr. Lauer, and in turn presented the medalist. Mr. Lauer then delivered a brief address citing the distinguished achievements of the medalist and presented him with the Anniversary Medal in bronze. A gold replica of the medal was then pinned to the medalist's coat and the party left the stage. The same procedure was followed in presenting the Daniel Guggenheim Medal, the Gantt Gold Medal, the A.S.M.E. Medal, and the Melville Medal, with the exception that Dr. Durand presented the Guggenheim Medal and L. P. Alford the Gantt Medal.

A list of the medalists follows:

A.S.M.E. FIFTIETH ANNIVERSARY MEDAL

Austria, HOFRAT ING. LUDWIG ERHARD. Presented by His Excellency Edgar L. G. Prochnik, Minister to the United States.

Belgium, BARON GASTON S. P. DE BETHUNE, for the Fédération des Associations Belges d'Ingénieurs. Presented by Vicomte de Lantsheere, Chargé d'Affaires, Belgian Embassy.

Canada, BRIGADIER-GENERAL CHARLES H. MITCHELL. Presented by His Excellency Vincent Massey, Minister to the United States.

Colombia, S. A., PROF. JULIO GARZON NIETO. Presented by His Excellency Enrique Olaya, Minister to the United States.

Czechoslovakia, DR. STAN. SPACEK. Presented by His Excellency Ferdinand Veverka, Minister to the United States.

France, M. GEORGES CLAUDE. Presented by His Excellency Paul Claudel, Ambassador to the United States.

Germany, PROF. DR. ING. CONRAD MATSCHOSS. Presented by His Excellency Friedrich W. von Prittwitz und Gaffron, Ambassador to the United States.

Great Britain, MR. LOUGHNAN ST. L. PENDRED. Presented by His Excellency Sir Ronald Lindsay, Ambassador to the United States.

Italy, PROF. DR. ING. LUIGI LUIGGI. Presented by His Excellency Giacomo de Martino, Ambassador to the United States.

Japan, DR. MASAWO KAMO. Presented by His Excellency Katsuji Debuchi, Ambassador to the United States.

Mexico, SEÑOR ING. NORBERTO DOMINGUEZ. Presented by His Excellency Manuel C. Téllez, Ambassador to the United States.

Netherlands, PROF. IR. DANIEL DRESDEN. Presented by His Excellency J. H. van Royen, Minister to the United States.

Sweden, MR. VILHELM NORDSTRÖM. Presented by His Excellency W. Boström, Minister to the United States.

Switzerland, PROF. DR. AUREL STODOLA. Presented by His Excellency Marc Peter, Minister to the United States.

United States, DR. C. E. GRUNSKY. Presented by the Honorable Joseph P. Cotton, the Acting Secretary of State.

Uruguay, S. A., PROF. DONATO GAMINARA. Presented by His Excellency J. Varela, Minister to the United States.

THE DANIEL GUGGENHEIM MEDAL

First Award

Medalist for 1929, ORVILLE WRIGHT. Medal presented by Wm. F. Durand, President, Guggenheim Medal Board.

"To Orville Wright, for design and construction, with his brother, now deceased, of the first successful engine-propelled airplane." With such simplicity of citation the Board of Award bestowed the first Daniel Guggenheim Medal. But the achievement itself is one which had baffled scientists, technicians, practical men, and dreamers ever since the first inquiring mind watched a bird in flight.

Orville Wright was born in Dayton, Ohio, in 1871, and educated in the public schools. He and his brother Wilbur experimented with models of airplanes practically all their lives. They saw the problem of successful flight as twofold: First, they figured they must produce some form of glider which would stay in the air long enough to give them actual experience in the air; and then they needed an engine light enough but powerful enough to supply adequate motive power. The story of their experiments with gliders, and of their development of an engine which would successfully raise and keep a plane aloft, is a familiar one. Their first successful flight with a heavier-than-air machine was made on December 17, 1903. They are the inventors, too, of the system of controls used in practically all flying machines today.

Mr. Wright's contribution to aeronautics has been one of practical achievement through experiment backed by thorough scientific research. As director of the Wright Aeronautical Laboratory in Dayton he is still contributing to the safety and efficiency of heavier-than-air flight. Honors and medals have come to him from aeronautical and scientific organizations all over the world.

THE GANTT GOLD MEDAL

Medalist for 1930, FRED J. MILLER. Presented for the award by Dexter S. Kimball, Past-President of the Society. Medal presented by L. P. Alford, Chairman, Gantt Medal Board.

When Fred J. Miller was factory manager for the Remington Typewriter factories, he engaged Mr. Gantt as his consultant on management problems, and a friendship began between the two men which terminated only with Mr. Gantt's death. Mr. Miller

Medals Awarded at A.S.M.E. 50th Anniversary

(*Above*)
A.S.M.E. MEDAL

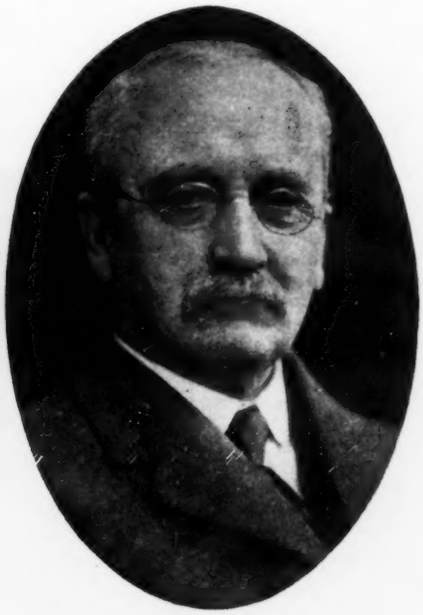
(*Below*)
GANTT MEDAL

THE
GUGGENHEIM MEDAL

THE
MELVILLE MEDAL

THE A.S.M.E. 50TH ANNIVERSARY MEDAL

Recipients of Medals Awarded at 50th Anniversary



The Medalists

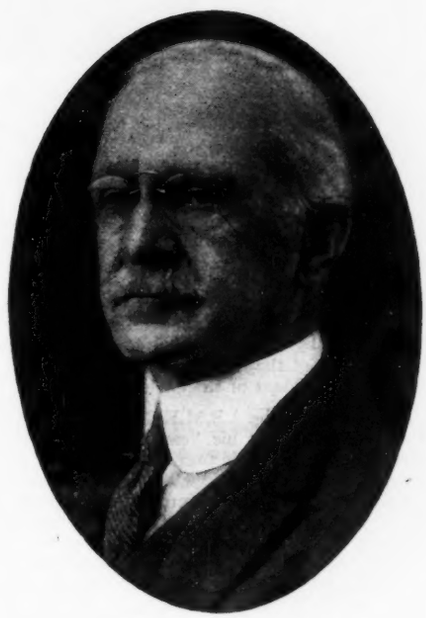
Above
HONORABLE HERBERT HOOVER
Hoover Medalist

Upper Left
ORVILLE WRIGHT
Guggenheim Medalist

Upper Right
WILLIAM LEROY EMMET
A.S.M.E. Medalist

Left
JOSEPH WICKHAM ROE
Melville Medalist

Right
FRED J. MILLER
Gantt Medalist

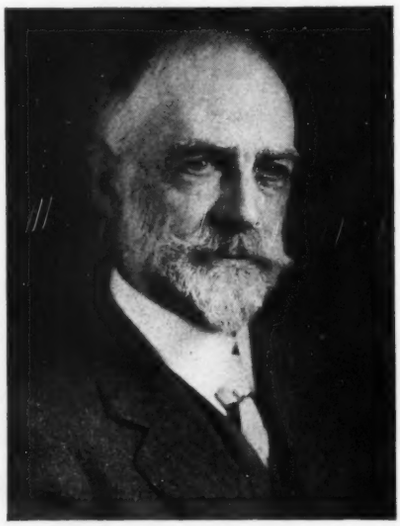


The A.S.M.E. Fiftieth Anniversary Medal

The Fiftieth Anniversary Medal, shown on the bottom of the opposite page, was presented to distinguished engineers selected for this honor by the engineering profession of their countries. The medalists are: *Austria,* Hofrat Ing. Ludwig Erhard; *Belgium,* Dr. Albert De Smaele, for the Fédération des Associations Belges d'Ingénieurs; *Canada,* Brigadier-General Charles H. Mitchell; *Colombia, S. A.,* Prof. Julio Garzon Nieto; *Czechoslovakia,* Dr. Stan. Spacek; *France,* M. Georges Claude; *Germany,* Prof. Dr. Ing. Conrad Matschoss; *Great Britain,* Mr. Loughnan St. L. Pendred; *Italy,* Prof. Dr. Ing. Luigi Luiggi; *Japan,* Dr. Masawo Kamo; *Mexico,* Senor Ing. Norberto Dominguez; *Netherlands,* Prof. Ir. Daniel Dresden; *Sweden,* Mr. Vilhelm Nordström; *Switzerland,* Prof. Dr. Aurel Stodola; *Uruguay, S. A.,* Prof. Donato Gaminara; *United States,* Dr. C. E. Grunsky.

appreciated Mr. Gantt's perception of the community of interest between worker and management, his fairness in insisting upon labor's increased profit from increased production, and the methods he advocated for making his industrial philosophy practical from all points of view. Shortly before Mr. Gantt's death Mr. Miller was associated with him in the installation of management methods and after Mr. Gantt's death he continued in the management of his enterprise for three years. Since then Mr. Miller has been engaged in the installation of modern methods of management and in advising on the principles of such installations. In recognition of the fact that Mr. Miller, in the Remington factories, made one of the first applications on a large scale of sound principles of scientific management, the Gantt Gold Medal for 1930 has been awarded to him.

Fred. J. Miller was born in Yellow Springs, Ohio, in 1857. After a high-school education he entered industry to serve a four-year apprenticeship as a machinist. He became interested in shop-management problems early in life, and while acting as foreman of Warder, Bushnell, Glessner and Company he published accounts of the methods he was using there which attracted the attention of the *American Machinist*. The result was that he was called by the *American Machinist* to an editorial position, from which he rose to be editor-in-chief. In this position he took advantage of the unusual opportunities offered, and became as familiar as any man in America, possibly, with the methods and processes of machine manufacture both here and in Europe. After twenty years in journalism, Mr. Miller was for nine years general manager of the group of Remington Typewriter Factories. During the war he was commissioned Major of Ordnance in the United States Army, where he was engaged in organization and personnel work.



WILLIAM F. DURAND

A.S.M.E. MEDAL

Medalist for 1929, WILLIAM LEROY EMMET. Presented for the award by Arthur M. Greene, Jr., Chairman, Committee on Awards of the Society. Medal presented by Conrad N. Lauer, Vice-President of the Society.

The award of the A.S.M.E. Medal for 1929 is made to Mr. William LeRoy Emmet for his "contributions in the development of the steam turbine, electric propulsion of ships, and other power-generating apparatus." He directed the development of the Curtis turbine by the General Electric Company, every detail of which was radically new; designed the machinery for the first ship driven by electric motors; was the first serious promoter of electric ship propulsion; and developed the mercury-vapor power process.

Mr. Emmet was born in 1859 at Pelham, N. Y., and was graduated from the U. S. Naval Academy. He left the Navy, however, to to take up electrical engineering. His most important electrical work has been in the development of the general use of alternating currents and in the invention and design of machinery to further the practical application of alternating currents. In the mechanical-engineering field, his work in the development and introduction of the steam turbine has been outstanding. He is the inventor of the vertical-shaft steam turbine, of which a large number were built, and many details of turbine design now in general use are to his credit. He is best known recently for the development on a commercial scale of the mercury-vapor process for the generation of power.

Most of Mr. Emmet's work has been done in connection with operations of the General Electric Company and in close association with General Electric engineers. He is a pioneer in new methods who has made it his special business to find new scope for the talents and facilities which this organization affords.

MELVILLE MEDAL

Medalist for 1929, JOSEPH WICKHAM ROE. Presented for the award by Arthur M. Greene, Jr., Chairman, Committee on Awards of the Society. Medal presented by Conrad N. Lauer, Vice-President of the Society.

Professor Roe's paper, "Principles of Jig and Fixture Practice," presented at the Annual Meeting of The American Society of Mechanical Engineers in December, 1928, won for him the award of the Melville Medal for 1929. The Committee's decision to award the medal for this paper as "a thesis of exceptional merit" is based upon the fact that it presents for the first time in condensed form a résumé of the principles of design of jigs and fixtures and adapts the formulas derived by the Society's Materials Handling Division to the economic problems involved in determining the investment justified in jigs and fixtures.

ROBERT A. MILLIKAN

Joseph W. Roe was born in New York in 1871 and was graduated from Sheffield Scientific School in 1895. He became interested in machine tools, their problems in design and manufacture, early in life, and had years of practical experience with these problems, with various firms, before entering the profession of teaching. His book, "English and American Tool Builders," is an important historical contribution on the machine-tool industry. Professor Roe's interests, apart from engineering education, still lie in the machine-tool field and in the practical problems of industrial management. He has served as president of the Society of Industrial Engineers. In 1925 he directed a study of civil aviation for the Department of Commerce and the American Engineering Council. (He had been a major in the Air Service of the United States Army during the World War.) He accepted his present position as professor of industrial engineering and head of the department of industrial engineering at New York University in 1920, following more than a decade as a member of the engineering faculty at Yale.

THE ANNIVERSARY DINNER

The Fiftieth Anniversary Dinner, held at the Mayflower Hotel on Tuesday night, will long be remembered as an almost perfect affair. At seven o'clock, their excellencies, the ambassadors of the several countries whose engineers had been honored at the convocation for the conferring of awards, their wives and guests having assembled with the members of the Society and their guests to the number of more than eight hundred, four flourishes of the trumpet announced the arrival of the President of the United States and his party, and as the Marine Band played "Hail to the Chief," the President crossed the room and took his place amid enthusiastic applause.

Following the dinner the toastmaster, Dr. William F. Durand, past-president of the Society, expressed the great regret which every one felt at the unavoidable absence of Mr. Charles Piez, president of the Society, and called upon Secretary Calvin W. Rice to read the greeting which Mr. Piez had written. Mr. Piez wrote as follows:

We have gathered here in celebration of the Fiftieth Anniversary of our Society, and I cannot refrain from expressing my deep regret that the disability I am at present laboring under has made it necessary to welcome this splendid assemblage by proxy rather than in person.

Future historians will refer to the half-century just ended as an age of wonders. The telephone, the electric light, the tremendous development and wide distribution of electric energy, the X-ray, wireless, the automobile, the aeroplane, the radio, have reduced miracles to commonplaces. It has been an era of brilliant intelligence and extravagant daring in the world of mechanical development. The engineer's mind has been in a constant ferment producing new ideas, out of which modern industry has arisen.

The organization of our Society was coincident with the beginning of this era, and it is fitting, therefore, that its Fiftieth Anniversary should be marked by something more than the mere passing of a period of time. The Society, in its short existence, has become a treasure house of engineering knowledge and engineering progress. It has stored up in its archives the engineering attainments of the past half-century. It has encouraged genius and prospered invention. It has become a forum for the discussion and solution of engineering problems.

The mechanical engineer is a very important but a very modest man. He cares nothing for effect, everything for results. He is reticent and is not given to self-exploitation. But he has hopes and aspirations which ought to find expression.

To thrive, the profession must have a common aim, a common purpose, which cannot be attained except through the medium of its National Society. Without that it would be as bricks without mortar. It is my firm conviction, based on a membership of over thirty years, that The American Society of Mechanical Engineers has added more to the reputation of its members than have their individual engineering attainments.

The supreme achievement of the engineer, after all, has been the speed with which he has made available, for the general use of mankind, the ideas of the inventors and discoverers of that highly imaginative epoch.

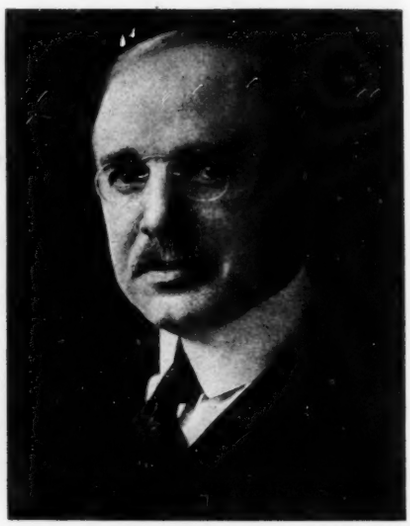
The increasing recognition of the engineer as an important factor in industry is evidenced by the rapid growth in the number of engineering schools and in the number of engineering graduates.

The engineer's field, too, is widening. He is no longer confining himself to purely mechanical design and development, but has invaded the field of industrial relations as well. It has been in large measure due to the engineer that management has been raised to the dignity of art, and that it is now generally reccgnized as the most important factor in the conduct of industry.

The change in the status of the mechanical engineer may well be made one of the principal themes for discussion at this Fiftieth Anniversary of our Society, and no better occasion for accenting this change could have been selected than this gathering at the Nation's Capitol; and I predict that this celebration will mark the beginning of a second half-century which, in progress and achievements in mechanical engineering, and in growth of our Society, will far exceed the accomplishments of the fifty years just ended.

DEXTER S. KIMBALL

CONRAD N. LAUER



J. V. W. REYNDERS

DR. MILLIKAN'S ADDRESS

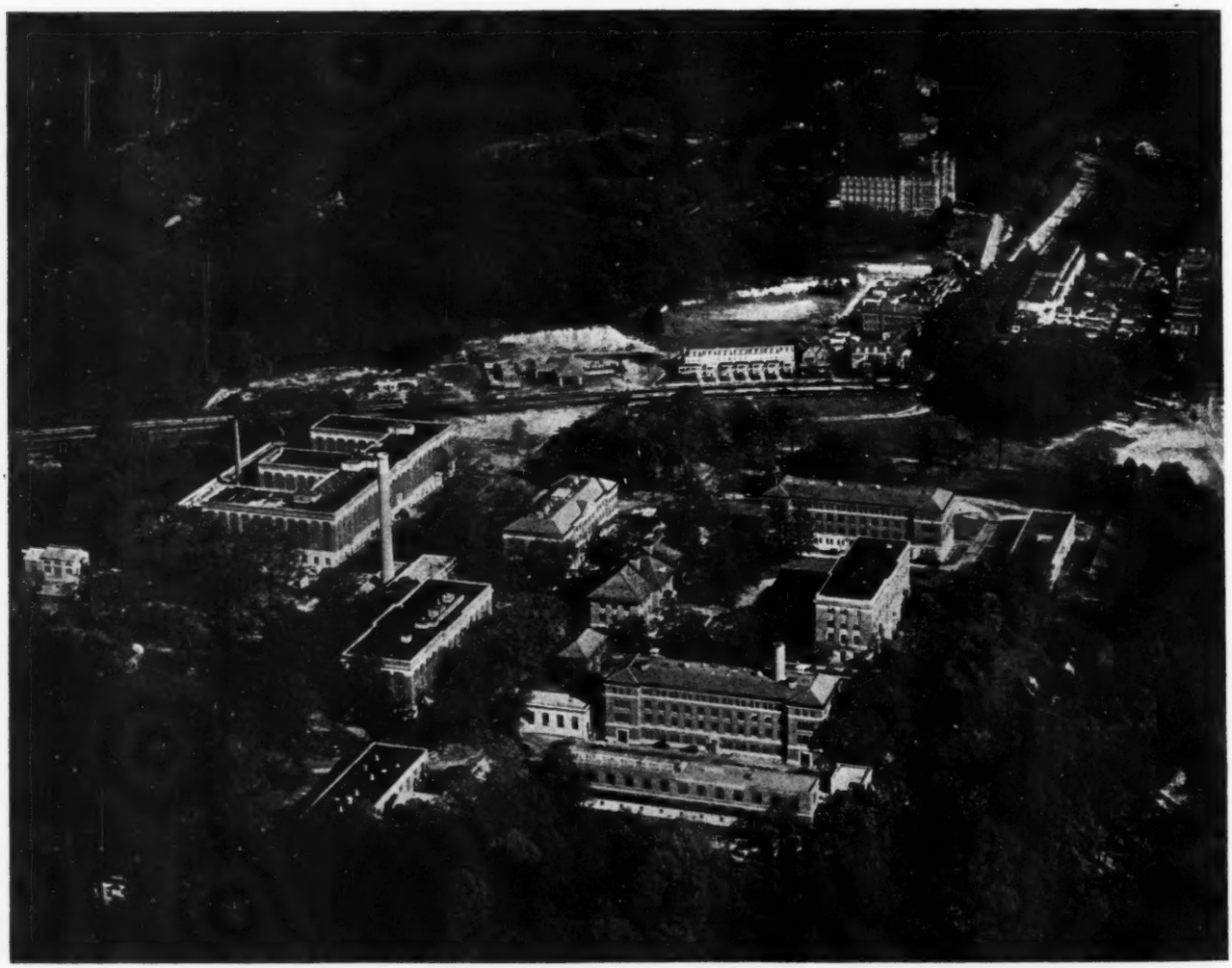
Dr. Robert A Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology, Pasadena, Calif., Nobel prize winner in physics in 1923, A.S.M.E. medalist in 1926, Edison medalist of the A.I.E.E., Hughes medalist of the Royal Society of Great Britain, research physicist, author, interpreter of science to the layman, gave the principal address at the Fiftieth Anniversary dinner. The address dealt with the bond between pure physics and engineering.

Dr. Millikan showed that when primitive man found a use for fire, "the age of the brute was gone and the age of man was born." The increasing uses of fire he traced down to the time of Joule, seventy-five years ago, when, for the first time, the equivalence of heat and work was experimentally established, and thence to a very few years ago when Einstein "reorganized the whole physical world under the hegemony of fire."

He then divided his address into four parts, having to do with (1) the direction and shape of the curve of history itself, (2) the method that seems to have been used in drawing that upward curve, (3) the identification of its draftsmen, and (4) what seem to be our own opportunities and responsibilities as scientists and engineers in connection with it.

Upon the first subject Dr. Millikan was optimistic, because the curve of evolutionary development has been steadily upward, and because there is abundant reason to expect that man, with his rapidly increasing control over his environment, will be able to stabilize somewhat his own curve in the future so as to prevent at least some of the fluctuations born of panic and ignorance that it has shown heretofore.

On his second point Dr. Millikan showed that prior to the dawn of modern science, empiricism, which was the method of primitive man, was inadequate to unlock the secret that heat was energy that could be made to work. "Mechanical engineering is, broadly speaking," he said, "the practical knowledge of the use of energy-transforming machines." The knowledge upon which it is based did not exist until it was borrowed from science. The fact that such science existed, he said, "makes the future bright with hope, not only for the scientist and engineer, but for the race itself, for it is the story of the discovery of the present, and, presumably, of future progress." Although men had known fire and had done work for untold ages, he pointed out, no one had ever worried his head about the relation between the two until scientists had established the concept of heat as the kinetic energy of molecular motion. "All this was necessary before



An Airplane View of the United States Bureau of Standards

the idea could arise that fire could be used to do the world's work for it, could be made to lift the burden from the backs of human slaves."

Speaking of this third point, Dr. Millikan said that the draftsmen of the curve of progress were to be found in two groups: the physical scientists and engineers, "whose job it is to see that the sun's rays, past and present.... are harnessed to the best advantage possible for doing the work that mankind needs to have done." But this job is not limitless without proper control of food supply and population, which, he pointed out, were the especial concern of the biologist and the educator.

Coming to his fourth point, the direction of social forces, Dr. Millikan asserted that "no man is fit to do that job who has not had an education that makes him not only fully conversant with the scientific method, but fairly conversant, too, with the foundations of science itself."

Not wishing to lay all the emphasis on material things, Dr. Millikan felt it necessary, nevertheless, to point out that adequate food and shelter, and leisure for intellectual and social development for all, were indispensable to race progress.

Dr. Millikan's concluding statement is of such significance as to warrant quotation in full. After showing that the scientist and engineer will continue to utilize the sun's fire for man's good, he said:

"But when all this is done, the job of decent living is only just begun. What man will do with his leisure and his new-found powers is not our job as scientists and engineers, but it is our job as citizens, and it is my conviction that the training in the objective method which science and engineering furnish, if coupled with the adequate understanding of human values that comes from suitable familiarity with history and literature, constitute the best preparation for life in almost any of its phases that can be obtained today. If my son wanted to be a lawyer, I would give him a scientific education as the best preparation for the law. Society needs knowledge and understanding in its leadership, and increasingly so as it becomes increasingly complex with the growth of new scientific methods and processes. Since the foundation of education is obviously, first, a training in the objective method, and, second, a thorough knowledge of the world in which we have to live, I anticipate the increasing social leadership of men well grounded in the fundamentals of science. That is one of our opportunities and our responsibilities as scientists and engineers."

The Hoover Gold Medal Award

The Anniversary Dinner had a deeper significance than the commemoration of the Fiftieth Anniversary of the A.S.M.E., for it had been made the occasion of the institution and presentation of the Hoover Gold Medal.

The Hoover Gold Medal has been instituted to commemorate

the civic and humanitarian achievements of Herbert Hoover and to him the first award is made. From time to time the medal will be awarded by engineers to a fellow-engineer for distinguished public service.

The trust fund creating the award is the gift of Conrad N. Lauer, of Philadelphia. It is held by The American Society of Mechanical Engineers and is administered by a Board of Award consisting of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

J. V. W. Reynders, past-president of the American Institute of Mining and Metallurgical Engineers, delivered the address presenting the medalist. He said in part:

The medal which we are here dedicating is intended to recognize the collaboration of engineers in all that goes to make up the body and spirit of our institutions—it marks the reconsecration of our profession to the welfare of humanity. . . .

The mechanical engineers, collateral heirs of ancient and age-long predecessors in the fields of mining and civil engineering, have indeed passed the half-century mark of their corporate existence, and yet when we contemplate the vast changes that have occurred in this country and the world over, for which this branch of the profession has been so largely responsible, it is not the age, but the youth of the organization which is significant. . . .

The record of accomplishment set against the youthfulness of the art is indeed extraordinary, but if the progress of the half-century now passed fills one with amazement, what shall be said to the prospect of the years to come?

What will be the effect on our social structure fifty years hence of an additional 100 million population? What will be the nature of this population? Will it have retained those characteristics which we have come to regard as distinctly associated with our Anglo-Saxon tradition, or will it have become tinged with, if not dominated by, impulses arising from other and more recent accessions to our racial composition. Will the building up of our social structure have proceeded so equitably as to satisfy the reasonable urge of an enlightened people? Will the sectional differences of interest inherent in our far-flung domain have continued to be submerged and subordinated to the national welfare? Will we have felt the effects, in any serious degree, of the diminishing reserves of our unexampled natural resources, of oil, of copper, of lead?

These are some of the great unanswerable questions of the future. Their solution must be the preoccupation of patriotic leadership in the years to come. The problems which now so conspicuously burden our headlines will have lost their prominence and others of more fundamental and far-reaching character will have taken their place.

No one profession or calling, nor any particular section of the people has a call to service beyond any other, but there can be no doubt of the duty and of the ability of the engineering profession to take a large and increasing part in the development of a social system which in scale and dynamic qualities is without precedent. . . .

We may project our minds to a distant period, when this society will have rounded out the second semi-centenary of its existence, and conceive of a national grown in spirit as it will have gained in size, and matured in all that affects the contentment of its people. Conspicuous among the builders of this great superstructure we confidently look forward to a roster of distinguished medalists who will have become a heritage of this great calling, and whose names may appropriately be classed with the one whose unselfish record of service and accomplishment will continue for all time to be an inspiration to his colleagues and to every good American, HERBERT HOOVER.

WASHINGTON'S HOME AT MOUNT VERNON

PRESIDENT HOOVER'S RESPONSE

Following Mr. Reynder's address, Dean Dexter S. Kimball, president of the Board of Award and past-president of the A.S.M.E., presented the medal to the Honorable Herbert Hoover, who responded as follows:

I am glad to join with my fellow-members in this celebration of the Fiftieth Anniversary of the founding of The American Society of Mechanical Engineers. It would be a difficult task to measure the blessings brought by this Society through the stimulation of invention from the raw material of pure science through the improvement of method, through the adequate training of engineers, and the advancement of knowledge in a large sense.

During its span of life it has contributed a great part in the development of an art into a mighty profession upon whose capacity and fidelity so much of human progress must rest.

I feel especially honored that the combined engineering societies should, through the beneficence of Mr. Lauer, have established a new distinction among engineers, and should have designated me as the first recipient. The purpose of the medal is to mark the public service of men who have gone outside of their strictly professional work to interest themselves in civic and humanitarian affairs, and the engineers have something to contribute to public service. I need but cite but one direction among the many that one could find.

With the application of science to the development of our great national tools, our engines, our railways, our automobiles, our airplanes, our steamships, and our electric power, and a score of other great implements, together with the supplies of materials upon which they depend, the engineer has added vastly to the problems of government; for government must see that the control of these tools and these materials is not misused to limit liberty and freedom, and that they advance and do not retard equality of opportunity among the whole of our citizens.

These great discoveries and inventions have brought great blessings to humanity, but they have multiplied the problems of government, and the perplexity of these problems progresses constantly with the increase of our population. Every county government, every municipal government, every state government, and the Federal Government itself, is engaged in constant attempt to solve a multitude of public relationships to these tools which the engineers by their genius and their industry constantly force on to the very doorstep of the Government.

And in solving these problems we have need for a large leavening of engineering knowledge and of the engineering attitude of mind and the engineering method. These problems of public relations are unsolvable without the technical assistance of the engineer himself. They are unsolvable without the fundamental engineer's approach to the truth, which is first to determine the fact, arrange these facts in proper perspective, and then to distil the truth from them in the retort of experience.

Engineers do not undertake to build bridges, power plants, or railroads without knowing the service that they are to perform, without infinite patience in discovery of economic and scientific fact, without an adaptation of experience, without giving consideration to the capacity of the human material available to conduct them, and without the final crystallization into positive and constructive action.

No one emotion enters into these determinations. Emotion is permissible only in contemplation of their service to humanity. But when the problems which these great tools create come to the door of the Government they are at once emotional problems, for the resolution of our people for equality of opportunity, for freedom from domination, for maintenance of individual initiative, for liberty of action, arises from the very deepest of human emotion. And yet if we were to find a solution to these problems, if we would deal with them constructively, we must traverse the same hard road in determining the service we wish to perform, and with the same infinite patience discover the economic and scientific facts, with the same care and regard for adaptation of experience, with the high regard for the human material available to conduct our administration, and with the same positive action in their application.

Our greatest difficulty is dealing with these problems of government when emotion comes first. The facts and technical knowledge come but slowly, and are often lost in a sea of embittered controversy.

It is for all these reasons that the engineers with their training, with their attitude of mind, and their method, can contribute to the solution of the problem which arises from their own creation.

I am not advocating that all public service be turned over to engineers. I have a high appreciation of the contribution of the other professions, but the engineers I do insist have a contribution to make to public service and they have obligations to give that contribution, and this distinction which has been established by the Engineering Foundation should mark this necessity and should stimulate activities of our engineers in such service.

WEDNESDAY IN WASHINGTON

Wednesday in Washington was devoted to excursions, sight-seeing, and the reception at the White House. The first excursion of the morning was to the Navy Yard to see the naval gun factory, the experimental model basin, the wind tunnel, and the diving school. Sight-seeing tours of Washington, Arlington, Georgetown, Fort Meyer, and Mount Vernon were arranged for those who did not visit the Navy Yard. In the afternoon the Bureau of Standards, where special arrangements had been made to inspect the laboratories where work was in progress, and other important government buildings were visited. At the White House Reception, President and Mrs. Hoover shook hands with more than one thousand guests.

The Use of Wire Rope by Steam-Electric Generating Plants[1]

By J. R. McCAUSLAND,[2] PHILADELPHIA, PA.

The task undertaken by the A.S.M.E. in formulating and directing research in the field of wire rope is a timely and noteworthy effort in the direction of scientific advancement. The widespread interest manifested at the preliminary meetings of the wire-rope committee gives promise of positive results.

As a user of wire rope the Coal Bureau of The Philadelphia Electric Company System has kept careful and accurate records over a period of ten years on wire ropes used in the service of hoisting and hauling equipment for the handling of coal and ashes. These records, together with supporting data, are presented in the following paper as a contribution to wire-rope research.

RESPONSIBILITY for the life of wire rope resolves itself into the main categories of materials, manufacture, installation, operation, maintenance, inspection, and last, and if not most important, the human element with regard to the use and care of rope.

The primary requirement of material entering into the manufacture of the cable is uniformity of quality. Next in importance are the physical properties of strength, resilience, and hardness necessary for a particular service.

Uniformity is also a basic necessity in the fabrication of wire rope. Three other factors of equal importance that have a bearing on the life of the rope are the type of construction, the shape of cable, and the factor of safety, used to the end that the life of a cable may be a maximum for the conditions of stresses and wear in the particular service for which the cable is manufactured.

Equipment on which cables are to be used introduce factors which may increase or decrease the life of a given cable. Such are sheave diameter, weight, and inertia for a given rope size, load, and speed; groove profile and surface material, journal friction—governed by type of bearing employed, number and type of return bends, relative positions of drums and sheaves, fleet of sheaves, type of grips on cableways, etc.

Operation factors affecting cable life are height of lift, load per trip, number of stops, number of cycles, running speed, acceleration and deceleration, smoothness of operation, and nature of atmosphere surrounding the equipment.

Maintenance involves care in the lubrication of cables, dressing of worn or scored grooves, alignment of sheaves, splicing of cables, and the making of end connections.

Inspection determines when the life of a cable shall be considered terminated.

The Human Element in Operation

In the author's estimation the greatest single factor affecting the life of wire rope is the human element, or the attitude of men to its care and use. In a field which is as complex and at best as little understood as that which governs the life of wire rope, it is an easy matter for the men directly responsible on the job to invent reasons for cable failures. In probably nine times out of ten the operator will blame the quality of rope rather than investigate possible causes for rope failure. Consequently one of the first prejudices to be broken down is the idea on the part of operators that cables in general are manufactured cheaply and haphazardly, resulting in their inherent weakness. It has been a policy of the author's company to send its operators on an inspection trip through the manufacturing plant of a reputable wire-rope concern. In every instance the men return with the conviction that a great deal of thought, care, and expense is employed to turn out the product which the operators handle.

The Rope Manufacturer as an Adviser

Cooperation with rope manufacturers is essential to the attainment of maximum rope economy for any given service. In the absence of accurate methods of dynamic testing of wire rope, the purchaser is dependent upon the rope manufacturer for guidance in the selection of the proper rope for his particular purpose. It is granted that the manufacturer has definite experimental knowledge from other similar applications upon which he can base his recommendations as to rope material, lay, and construction features best suited to the job. He can also give helpful advice as to changes in equipment design, methods of attaching load to rope, of splicing, of operation, and of equipment maintenance, which are instrumental in prolonging rope life. His claims, though, may be extravagant; and gains made in rope life may not warrant the expenditures involved.

"Rope Sense"

Although wire rope in the abstract appears to be a very sturdy piece of fabrication, it nevertheless is subject to all the infirmities attendant upon moving machinery. It is subject to wear, to complex stresses, to corrosion. Failure in most cases can be anticipated by visual inspection after rope has seen service. Hence care of rope is little more than the exercise of common-sense precautions, or the use of what one manufacturer calls "rope sense."

Friction

In our use, abrasion is the most important factor contributing to rope failure. Abrasion always precedes the breaking of wires due to stresses. Corrosion plays no part in our failures. Thus, rope life is an inverse function of friction, and, conversely, any means employed to reduce friction increases rope life. Common sources of friction are:

1 Lack of proper lubrication
2 Misalignment of sheaves

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[2] Superintendent, Coal Bureau, The Philadelphia Electric Company. Mem. A.S.M.E. For the past twenty years Mr. McCausland has been associated with the engineering department of this firm in construction and operating work, serving also during this time with the United States Engineers in France during the World War. He studied mechanical engineering at Temple University in Philadelphia.

3 Smooth-surfaced drums
4 Restricted fleet of sheaves adjacent to drums
5 Improper shape of groove profiles
6 Worn or scored groove profiles
7 Stationary iron rope guides
8 Bucket sheaves and rope guides
9 General wear on fraction of whole rope
10 Scrubbing of adjacent ropes
11 Improper splicing.

1 Lubrication under all circumstances is a check on friction. Where the parts to be lubricated are easily accessible, and inspected, reasonable care by the operators can be expected. Wire-rope lubrication, however, by means of a paint brush, is inconvenient and tedious. Moreover, when compound, grease, or heavy oil is used, which has an affinity for coal dust in the surrounding atmosphere, inspection is difficult, disagreeable, and uncertain. Even if proper attention is paid to lubrication by

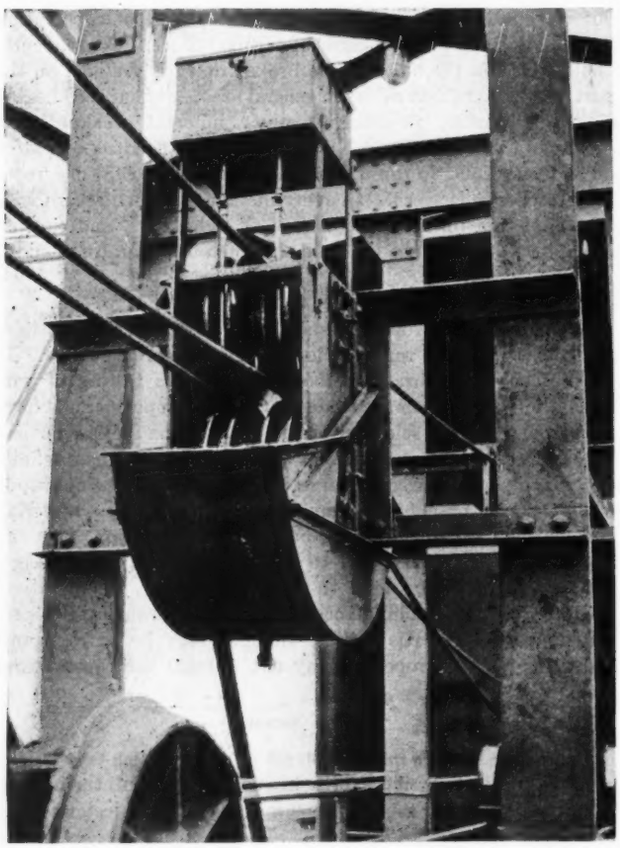


FIG. 1 CONTINUOUS ROPE-OILING DEVICE

the operators, the crust formed by the mixture of grease and coal dust defeats the purpose of lubrication by preventing the penetration of fresh lubricants and by acting as an abrading medium when passing the rope around sheaves and drums. To assure the proper lubrication of wire rope on our coal towers and cableway, a continuous rope-lubricating device (Fig. 1), which was developed by one of our operators, has been installed. It feeds a common, black, acid-free oil continously to the rope while operating, and penetrates to the core without forming a crust around the rope. Grease and compound, however, do find application in work under water to resist corrosion in the rope.

2 Misalignment of sheaves results in scrubbing of the rope against the sheaves.

3 Smooth-surfaced drums permit adjacent rope coils to scrub each other in winding and unwinding operations. Grooving the drum so as to space rope coils apart overcomes this difficulty.

4 Restricted fleet of a sheave adjacent to a drum produces an angle of lead between the sheave and drum which causes the

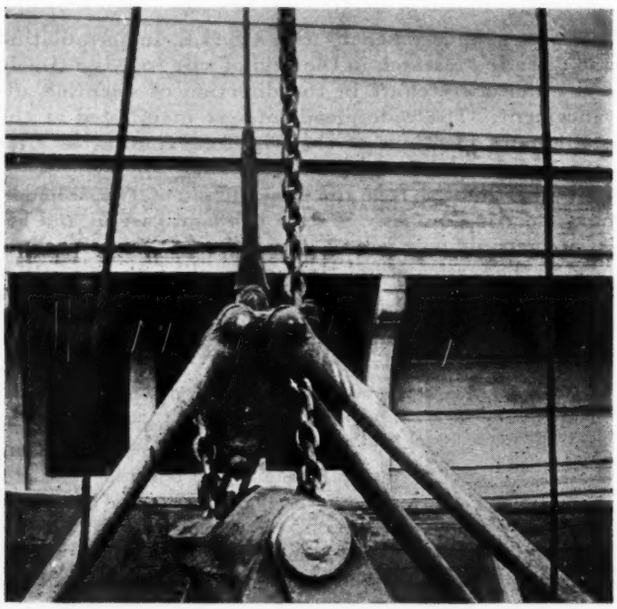


FIG. 2 EYE-SPLICE "BOOT" ON HOLDING LINE

rope to scrub against the sheave and the drum groove or against the adjacent rope coil on a drum where grooving is lacking. Our policy is to use single-layer, grooved winding drums with the adjacent sheave arranged to fleet the entire width of the drum. Abrasive wear and cable-crushing effect are thereby reduced to a minimum.

5 Groove profiles that pinch the rope aggravate abrasion. All of our sheave and drum grooves are U-shaped, having a diameter at the bottom of the U about $^1/_{16}$ in. greater than the nominal size of the rope.

6 The surface over which wire rope travels has an important effect on rope life. Ordinary metal surfaces of sheave grooves, idlers, and grips on cable roads will wear or score rapidly, with the result that severe abrasive action occurs on the rope. Our chilled-cast-iron idlers on cable roads were replaced with idlers of cast steel. These also wore rapidly. Finally the steel-idler groove surfaces were filled in with hard steel by welding, filed to the required diameter and heat treated, by which method longer life is obtained on both the rope and the idlers. Filling worn surfaces by welding was also tried on cable grips, but a better method was found. The top and bottom pieces of the grips were made of tool steel. Surfaces in contact with rope became polished in service, thereby minimizing wear both on rope and grip. The life of a tool-steel grip is about five years, thereby reducing the cost of grips by about 75 per cent.

7 Scrubbing action between rope and stationary iron guides may be eliminated by replacing stationary guides with sheaves. Where sheaves cannot be used, rope wear may be reduced by covering the iron guides with hardwood wearing pieces.

8 Clam-shell buckets of necessity have small-diameter sheaves. These, together with the twisting action of rope at the load end and the severe abrasion of the cable in passing through guides

and coal, cause buckling and failure at the bucket end more rapidly than elsewhere in the rope. To compensate for the more numerous failures at the bucket, ropes were purchased long enough to permit the bucket ends to be cut off several times. When the rope becomes too short after successive cuttings, it is replaced with a new rope. In the case of Chester Station, where more difficulty was experienced with lead between drum

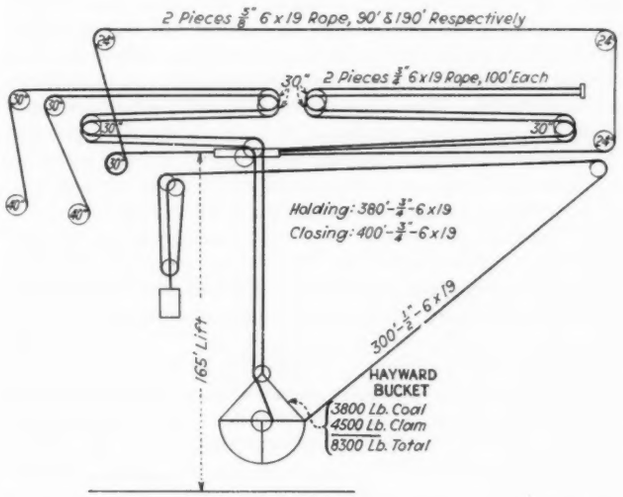


FIG. 3 ROPE DIAGRAM OF HAMMERHEAD TOWER AT CHESTER STATION

and adjacent sheave, the additional length of rope is coiled inside the drum. Only the required length is clamped on the drum so that the fleet angle is maintained at a minimum. As end cuttings require, additional rope is let out of the drum and reclamped.

9 It was found that approximately one-half of the holding and closing ropes from the bucket end suffered greater wear than the other half. At first the good half of a removed rope was used on cranes requiring shorter lengths. Later it was decided to wear the rope down completely by reversing it end for end and so distributing wear over the entire length. It is estimated that this method of reclaiming rope is equivalent to about 15 to 20 per cent of the rope life.

10 The eye splice of the holding line at the bucket is subjected to abrasion from the whipping action of the closing line. A splice "boot" designed by one of our operators and shown in Fig. 2 has served well in preserving splices, thereby contributing to rope conservation.

11 Splicing has an important bearing on rope life. Unless properly done, a raised strand will develop in service, with a consequent misapportionment of both wear and stress, which leads to early failure. Our operators are trained to pull the strands of a splice to an equal tension and to keep the strands perfectly round in order not to distort strands in other parts of the rope. The ends of strands on eye splices are tucked in even and true. Ropes on our cable roads are spliced endless on the machine. A 40-ft. or longer splice is used, the strands being carefully laid in and 30 in. of the ends tucked into the center of the rope of replace the core. The ends are taped before tucking in. A 30-in. tuck is found to resist cable grips better than the usual 18-in. tuck. To guard against strands slipping out of place, it is essential that the strand tucked in shall completely fill the void left by the removed core.

STRESSES

Rope stresses in our service break the outside wires of strands after abrasion has reduced their cross-section 30 to 40 per cent. When 50 to 60 per cent of the outside wires are broken in a 5-ft. length, the rope fails.

Bending, tensile, and shearing stresses are augmented respectively by—

1 Small sheave and drum diameters and reverse bends
2 Rapid acceleration and deceleration of load
3 Improper reeving of rope.

The degree to which these stresses are imposed upon ropes determines whether stress or abrasion is the paramount cause of short rope life.

1 Our original installation at Chester Station, which employed what was known as the "Watson rig" on hoisting, destroyed rope almost as fast as it was put on. The Watson rig, a counterbalanced hoist, had a large number of small-diameter sheaves and reverse bends. Due to the extraordinary number of rope failures, the Watson rig was replaced shortly after installation by the present hammerhead tower, shown in diagram in Fig. 3 and similar in structural appearance to the Richmond Station tower illustrated in Fig. 4. Still another type of tower is that utilized in our Schuylkill, Delaware, and Petty's Island plants and known as the steeple tower (Fig. 5). The names are derived from the construction of the tower supporting members. All of our present towers are of the hammerhead or steeple type, the selection of either being governed by

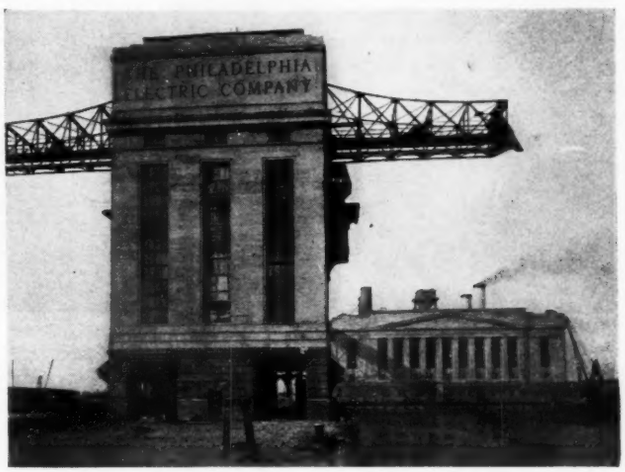


FIG. 4 HAMMERHEAD TOWER AT RICHMOND STATION

architectural features. In so far as operation is concerned, the hammerhead and steeple towers are identical. A grab bucket is raised or lowered by a double-drum hoist through leads operated over a trolley running on a horizontal boom which projects out over the boat to be unloaded. A separate drum controls the movement of the trolley. One man controls the entire operation. Our present equipment practically relegates bending stresses to secondary consideration.

2 Acceleration stresses, however, must still be reckoned with, especially after abrasion has weakened the ropes. Failure of rope due to acceleration stress is usually traceable to the operator. On a bucket hoist employing holding and closing lines, operation must be such that both lines carry their proportionate share of the load. An operator can cause a closing line to fail earlier than a holding line by hoisting with the closing line alone. On the other hand, the operator can cause the holding line to fail earlier than necessary by jerking the empty bucket to a sudden stop at the bottom of its travel. Operators have thor-

oughly impressed upon them the fact that the rapid starting or stopping of a load, jerking, and uneven cycles are as detrimental to cable life as wear and abrasion, especially after the ropes have become worn. The result is that operators exercise increased caution with increased age of the rope. No operator desires to be charged with the failure of a rope, regardless

FIG. 5 STEEPLE TOWER AT PETTY'S ISLAND

of its age. This spirit among the men is to a considerable extent responsible for the fact that we have four ropes at one of our stations which have handled from 250,000 to 366,000 tons each and are still working, whereas formerly the rope life was from 60,000 to 100,000 tons. When ropes such as these fail, not a single good section remains in the entire length. We now wear out the ropes completely, and ropes for cranes, which were formerly taken from good sections of hoisting ropes, must now be purchased.

3 Proper reeving of wire rope consists in uncoiling the full length required, in a straight line, removing all the kinks, winding the full length on the drum, and then unwinding it through sheaves to the load its entire length. This procedure will eliminate a good deal of initial twist encountered in new rope, relieving thereby some of the stresses encountered by the rope during service.

RECORDS AND COMPETITION

Records of duty on the various ropes used are kept by our yardmasters in the separate stations. These records are reviewed monthly and at yardmasters' meetings. Competition is fostered among the men on rope life as well as on other apparatus coming under their supervision. Problems are discussed at the meetings, where combined thought is put to work on the individual needs of each station. Constructive suggestions are encouraged, and at times rewarded.

Plans and policies are formulated with the aid of the men affected, resulting in smooth, cordial labor relations and the development of an esprit de corps, at once healthy and beneficial to all concerned. The men themselves have formulated rules of discipline and a system of penalties for operating errors by which they abide without trace of dissension. Records are maintained by the men themselves on time lost due to illness, accidents, or other causes; on careless mishaps affecting either men or equipment; and on time savings achieved in performing daily tasks. They take pride in the efficient condition of their equipment, the cleanliness of their plants, their personal appearance. Uniforms, laundry service, and shower baths are provided at all our unloading plants, which offset the handicap to personal appearance attending the handling of coal.

In the constant search for improvement, manufacturers' representatives are cordially received by our men, who are ready to cooperate along any lines of action holding promise of increasing the combination: efficiency—economy—safety.

CONCLUSIONS

The life of wire rope can be increased appreciably by proper care and lubrication, and in the selection and maintenance of sheaves, drums, and other apparatus pertinent to the life of rope. There is, however, a widely varying and inconsistent span of rope life when rope is used by the same individual in the same service and under the same conditions, which would indicate a lack of uniformity in materials or fabrication of the rope itself.

Francis and Propeller-Type Turbines in Sweden

THIS article describes a hydroelectric plant at Forshuvudforsen in Sweden where of the three turbines installed two are Francis and one a propeller type. When the plant was built two Francis units were installed (1917), but the power house was built to take three units. The spiral pits or scrolls and suction tubes to all three units were built at the one time, so that when the question of the third unit became actual, the installation of a propeller-type machine could only be agreed upon on condition that no alterations would be required to be made in the existing foundations or suction tubes. The plan of intakes, scrolls, and suction tubes is shown in the original article, together with the general arrangement of the propeller unit, which is of the Lawaczeck type. The sectional arrangement of this latter turbine differs but little in design from that of the Francis turbine. The main divergence is in the runner design, in that there is no ring at the outer circumference of the runner vanes.

The runners of the Francis turbines in this plant have diameters of 4210 mm., while the Lawaczeck runner is 4240 mm., or practically the same. The Francis runners to units Nos. 1 and 2 have 13 and 14 vanes, respectively, while the Lawaczeck runner has only six vanes. The vanes in the former are cast in one with the boss and outer ring, but in the Lawaczeck runner each vane is cast by itself and securely bolted to the runner boss.

The whole runner is of cast steel, and the six vanes are cast separately and secured to the boss by well-fitted bolts. The vanes were milled to form where they fit against each other and the boss, and after they were mounted the runner was machined to the external diameter required.

The plant has not yet been tested at site, and therefore data are not available for a comparison of the performance of the two types of turbine.—Geo. Willcock, Engr., Finnshyttan, Sweden, in *Canadian Engineer*, vol. 58, no. 7, Feb. 18, 1930, pp. 221–225.

The New Rôle of Aluminum

The Increasing Use of This High-Priced Metal in the Form of Structural Shapes in Places Where Considerations of Lightness and Strength Outweigh Those of Cost

THE commercial production of structural shapes from aluminum is significant from several points of view. It was an accomplishment not easy to achieve and required a combination of unusual and not easily developed metallurgical practice and the courage to apply on a large-scale rolling methods very substantially different from those with which we are familiar in the manufacture of steel- and copper-alloy shapes.

It was also significant that a market could be found in this country to employ the amount of structural shapes that a sizable mill can produce. The Aluminum Company of America seems to have adopted the slogan, "Equal strength with less than half the weight." We do not know to what the strength of aluminum structural shapes is presumed to be equal. We do know, however, that the "weight" in this case does not include the price tag. Aluminum shapes may weigh half as much as, let us say, plain steel shapes, but they cost several times as much, and customers had to be found who were willing to pay the increased price. It therefore becomes of interest to ascertain through analysis, as will be done later here, just what are the advantages that warrant a price in excess of 35 cents per pound for aluminum structural shapes.

Casting and Preheating the Large Ingots Needed for Aluminum Structural Shapes

The main obstacle in the way of producing aluminum shapes in the past has been the necessity of securing a sufficiently large, sound ingot, for as soon as rather restrictive dimensions were exceeded, the ingot began to show inclusions, such, for example, as internal shrinkage cracks. Apparently, therefore, a complete departure from the methods used in casting steel ingots or from those used in copper mills was imperative. The difficulty was accentuated by the fact that structural shapes obviously had to be made not from pure aluminum but from one of the so-called strong alloys, or those containing copper and magnesium. These alloys, however, are very prone to segregation, which is undesirable in structural shapes as it develops points of weakness.

The difficulties in the way of producing a sound ingot were therefore far more formidable than they are in the case of steel, and how great they are in the latter case is well evidenced by the fact that in ordinary steel practice we are still very far from having achieved the goal of making ingots that are completely sound, even after cropping.

Up to the time big aluminum ingots were developed, those used were very small in size. For wire making an ingot about 4 in. square and some 36 in. long was made in split molds. This practice, however, was unsuitable for the larger ingot. For rolling structural shapes a large slab ingot was developed, using a cast-iron mold called a "bathtub" because of its resemblance to that utensil. This is raised to red heat in a special furnace and then placed on a carriage in a pit under the furnace spout. It has a capacity of some 3000 lb., which means a volume of about that of a five-ton steel ingot. The method employed in teeming is peculiar, and everything done in the aluminum mill is very different from steel-mill practice. The melting furnace itself is apparently of the open-hearth type, with a capacity of about 20,000 lb. The metal from the spout is discharged into an auxiliary spout divided into two parts by a partition at the bottom which acts as a sort of dam and another partition which reaches to the top, the whole affair being only about 15 in. long and perhaps 10 in. wide. The metal from the furnace is discharged into the rear section of the auxiliary spout, from which it flows over into the front section after the pool formed by the dam is filled. The supply of metal is such that the pool level is always kept higher than the bottom partition but not quite as high as the top one, which prevents the scum on the surface of the pool from flowing into the mold. The front section has a hole at the bottom, through which the metal is discharged into a long red-hot cast-iron spout located in the interior of the mold. The operation requires several men, one of whom gradually raises the cast-iron spout so as to bring it to the level of the metal in the mold, and seems to require a considerable amount of skill.

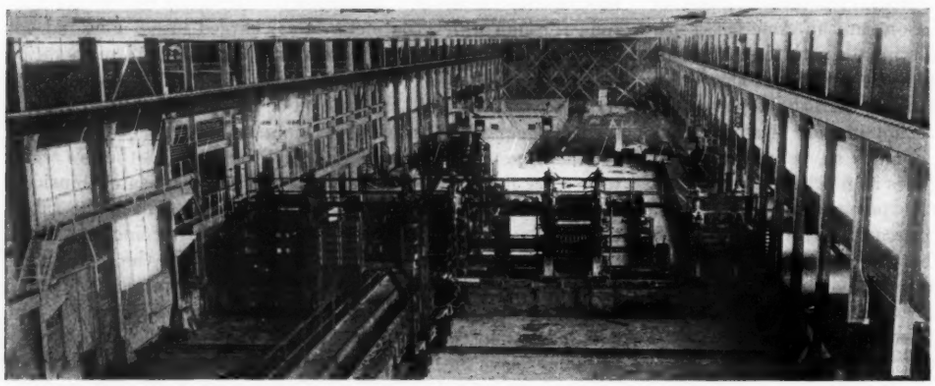
When the mold is completely filled the metal at the top seems to be very fluid, which would indicate that it is heated considerably above the melting point in the furnace. When the tub is filled it is moved on its carriage into a furnace forming part of the casting pit, whereupon the doors are closed and the metal is allowed to cool. In this way, the furnace containing the mold would seem to be merely the equivalent of a soaking pit, but it is more than that. The furnace is so arranged that a powerful flame plays on top of the mold while a water spray is striking the bottom and in some way is being gradually deflected upward along the walls. The result of this arrangement is that the cooling of the ingot takes place in a definitely predetermined manner, and apparently under close control. As the metal freezes from the bottom (presumably layerwise) while the upper part of the metal is maintained in a fluid state by the flame playing on it, the conditions are such as to counteract the tendency to form shrinkage cavities. It is not quite clear, however, how a certain amount of segregation can be prevented in this case. It may be that the rolling is so planned that the segregated metal goes into that part of the structural shape where it will do the least harm. This would be substantially along the lines of standard rail practice.

The solidified ingot is next transferred to the rolling mill, where it has to be preheated. In steel practice the ingot is taken out of the soaking pit at a high temperature and immediately delivered to the blooming mill. In aluminum mills this is obviously impossible, as the ingot when fully solidified is, on account of the water cooling, at too low a temperature to be rolled. The ingots are therefore reheated in electric furnaces where an extremely close control of temperature can be maintained. In general, the surface of the ingots in contact with the molds appears to be surprisingly good. The exposed upper surface, however, is not so good. Some ingots are rolled as they are, while on some the surface exposed to the air is machined off on a huge boring mill. Some ingots are scarfed on all four sides. This is apparently done when a particularly good surface is desired or when there are visitors in the mill. The blooming mill in its general arrangement does not differ much from standard practice. It is a Mesta unit of conventional type driven by a 5000-hp. direct-current variable-speed reversing-type motor with a flywheel on the motor shaft. The rolls are of a character to permit a comparatively wide choice of shapes. A manipulator of the usual type, though not as heavy as in steel mills, is provided.

A thing that is surprising to one accustomed only to steel-

mill practice is the small reduction that is made per pass. The billet seems to go back and forth without apparently decreasing in size. This is due, of course, to the fact that aluminum alloys are hot-short and cannot be given as brutal treatment as are steel billets. Naturally the cost of rolling is increased tremendously, and this is one of the reasons why rolled aluminum shapes are so expensive and are not likely to come down in price very much unless the composition of the alloy is radically changed.

There is, however, one advantage possessed by aluminum as compared with steel, and that is its ability to retain heat because of its very high heat capacity and the fact that even comparatively light passes help to maintain its temperature. As a result, the aluminum billet can be given many more passes in the blooming mill than would be possible with a steel billet. The mill is said to be the largest aluminum mill in the world, the rolls being 38 in. in diameter by 84 in. face.



THE STRUCTURAL MILL

Passing over such details as shears, which do not represent anything unusual, let us now proceed to describe the structural mill.

THE STRUCTURAL MILL

The structural mill consists of two three-high stands with rolls 26 in. in diameter × 60 in. face and one two-high stand with rolls 26 in. in diameter × 48 in. face. Tilting and trailer tables are installed on each side of the mill to catch the stock from the pass in one stand of rolls and shift it to the next pass. A feature of the structural mill is an overhead crane made of aluminum. The operation of the structural mill is substantially the same as in steel mills, except that here again the reductions are small and the number of passes necessary to achieve a given result is comparatively large. Because of the fact that the exposed area of the piece rolled is much larger in proportion to its volume than in the blooming mill, the temperature at which the rolling is completed is apparently either very close to the critical one or below it. The latter appears to be more likely. Anyway a heat-treating furnace for treating the finished pieces is provided, and is said to be again the largest of its kind in the world. Its length is such that structural sections 90 ft. long can be handled. The furnace is electrically heated. The structural piece is delivered to the carrier from a table after the ends have been trimmed. A little door in the furnace opens and the carrier enters together with the rolled piece. The piece is then picked up by means of lift fingers and moved across the furnace until it reaches the discharge table on the opposite side. The furnace is divided into twenty-six zones, the temperature of each being separately controlled by an automatic temperature regulator. Pyrometric equipment is installed to indicate and record the temperature throughout each zone of the furnace. A temperature differential of 10 deg. fahr. is maintained throughout the entire working area of the furnace, thus insuring absolute uniformity of heating throughout every portion of the structural sections heat-treated. The piece is discharged from the furnace by means of a power-operated roller table, and is automatically quenched as it leaves the furnace by means of high-pressure water sprays. It then passes to a transfer which brings it to the line of roller tables immediately adjacent to the furnace, and here it is straightened. It is then conveyed by means of another transfer to a roller-conveyor line where it is cut to length and its weight determined.

There are a number of features worthy of attention in this mill. One might hesitate to employ the adjective "dainty" in describing a huge place for making and rolling aluminum shapes, and yet in this case it would be quite legitimate. Because of the fact that electricity is almost exclusively used for heating and exclusively for conveying, there is no smoke nor dust. The mill buildings are high, provide a large amount of light, and, wonderful to relate, have no broken windows —which may be due to good policing or to the fact that the mill is new. The temperature of the metal handled is of course comparatively low, which makes the place pleasant to work in. The pieces are light and easily handled, the whole operation appears leisurely, and the beautiful silvery surface of aluminum adds to the feeling of agreeableness and cleanliness.

THE WIRE MILL

This mill is of very large size and makes everything in the wire line from heavy cables down to fine wires 0.005 in. in diameter. It has melting furnaces of its own as it uses pure aluminum instead of the high-strength alloy rolled in the structural-shape mill. The reason for this is that aluminum wire is extensively used in electrical work, where the high conductivity offered by pure aluminum is of more value than the mechanical strength with which the alloy metal is endowed.

The most interesting feature in this mill, and the only one of particular technical interest, is the casting of the ingots. This is done in split vertical molds with inside dimensions of about 4 × 4 × 36 in. The process is a leisurely one. No hot tops are used. Instead the mold is filled from a small ladle containing enough material for five or six ingots. Then the operator takes up a few pounds of molten metal from the ladle in a spoon and carefully dribbles it on to the top of the cast ingot. This limited equivalent of a hot top provides a supply of molten metal to care for the shrinkage, while the addition of fresh metal prevents the part exposed to the air from solidifying rapidly. Considering the small weight of the ingot and the time it takes to supply the metal needed from the spoon, it will be obvious that the procedure described is possible only with such a very high-priced metal as aluminum.

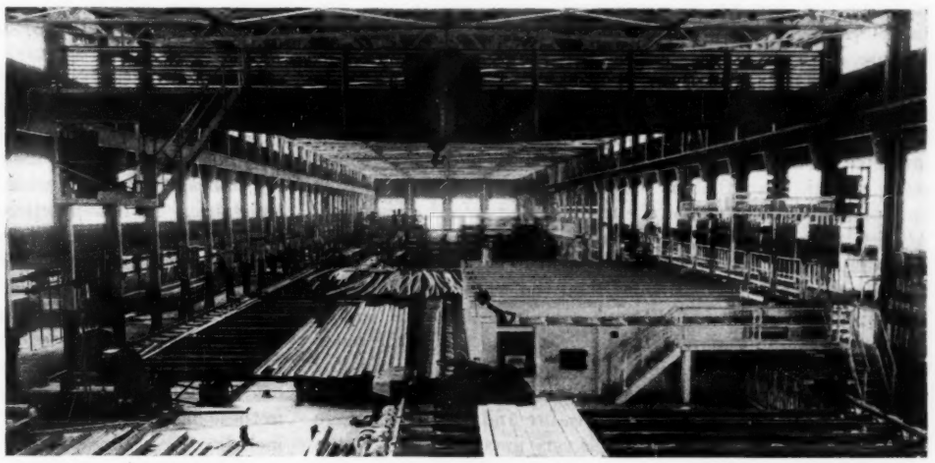
The rod mill is of the old looping type, and the wire mill itself is of prewar vintage. Its size, however, is impressive, particularly as it indicates an apparently large demand for aluminum wire in various forms.

ECONOMICS OF ALUMINUM STRUCTURAL SHAPES

Why are people willing to pay several times as much for an aluminum channel or angle as they do for an equally strong steel shape? There are two answers to this question.

In the first place, it should be noted that today the most important market for aluminum structural shapes is in the transportation field. These shapes are already employed to a notable extent in the construction of trolley cars, and are being seriously considered for railway cars, particularly for passenger transportation. The reasons why they are used in these two classes of transportation are not the same, and need to be clearly understood in order to appreciate the possible extent of their employment.

In American cities the trolley car competes with many other forms of transportation, such as buses, private automobiles, taxis, and, in some cities, subways and elevated trains. Furthermore, the trolley car itself occupies a considerable amount of space on streets already crowded to the utmost of their capacity and sometimes beyond it. Therefore, unless it is operated in a certain way it becomes instead of a public convenience a hindrance to traffic. These facts were quite clearly understood a long time ago, with the result that trolley cars were designed so as to be able to start quickly and develop their full speed in the shortest time and distance. As regards stopping, the same quick methods are applied. In this respect American trolley systems are very different from the majority of foreign ones. Ours are no faster than Continental ones, but they cover the ground quicker because they spend less time in starting and stopping. In other words, we use the same speed but a very much higher acceleration and deceleration than the nations of Continental Europe.



SHOWING SHAPES ON FINISHING TABLES—NOTE THE 10-TON ALUMINUM OVERHEAD CRANE

There are, of course, two ways of obtaining rapid acceleration. A certain amount of energy has to be spent to produce it, and this energy can be expressed as a function of mass and velocity. The velocity being fixed by the desire to obtain a given acceleration, we can either employ a larger amount of energy with the same mass or reduce the mass in order to cut down the amount of energy required. The first alternative is achieved by putting in a larger motor or a motor capable of giving a larger starting torque. Both are expensive from the point of view of first cost and cost of operation, and clearly do not afford a desirable solution of the problem. The second way is to reduce the mass, which means to lighten the car. This can be done, however, only in such a way as not to impair safety of operation or increase the cost of maintenance. It is because of this limitation that the wooden car is gradually being eliminated as a major element in transportation. The aluminum structural shape apparently answers the problem satisfactorily by providing a lighter element of construction without impairing the strength of construction and without creating a fire hazard. While an aluminum beam or shape is more expensive than a steel member having the same sectional modulus, its employment makes it possible to use a smaller motor and thus obtain an economy in first cost of the electric installation and in current consumption during operation. From the fact that the aluminum shape is finding a growing employment, as evidenced by the further fact that the mill of the Aluminum Company at Massena, New York, described here, appears to be a very busy place, it would seem that those primarily interested in the matter, that is, the managements of the various trolley companies, have found that it pays to use the more expensive material.

In railroad operation the matter of starting is of comparatively minor importance, because, unlike the case of the trolley car, the number of starts and stops per mile is a fraction alone at the worst, and may be completely neglected in the case of express passenger trains. On the other hand, in the case of railroads the dead weight carried per passenger is indeed enormous. Moreover an effort is being made to replace plain axle bearings by roller bearings. The life of the roller bearings depends on the load per bearing and the speed of the train. The latter is a matter of time schedules, and primarily will not be reduced to accommodate the bearing. It might be raised, however, if conditions permitted. With a given speed limit, the capacity of a given size of bearing depends on the weight of the car. If, therefore, we should be able to reduce the weight of the car we could put this saving either into reducing the size of the bearings for a given speed or retaining the same size of bearing and increasing the speed. Either of these possibilities has a great appeal to railroad men, in addition to which the lower weight of the equipment cannot but be reflected to some extent in the fuel bill and perhaps in maintenance costs.

Railroads have, of course, two possible ways of solving this problem. One is the employment of alloy steels, which can be done satisfactorily only, however, through a complete redesign of the present equipment, and is rather more radical a procedure than the railroads with their enormous investment in existing equipment are likely to adopt in a hurry. The other way is to leave things as they are, use the same physical specifications, which have already proved to be good by long experience, and simply replace heavier members by lighter members. This is an easy and comfortable way, and is made possible today by the availability of aluminum structural shapes.

There are several contributing factors materially assisting the growth of employment of aluminum structural shapes in transportation. Aluminum alloys are essential to the development of aircraft, and an enormous amount of research work is done in that direction by governmental agencies who can afford to spend large amounts of money where national defense is involved. In this way, the aluminum industry is benefited and supplied with information which, alone, it would have been probably unable to secure. Incidentally, duralumin type of alloys have also been primarily developed for aircraft use.

Survey of Engineering Progress

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS

Circulation of Lubricating Oil in Aircraft Engines

FOR a given rate of operation of the motor, the temperature of the oil would be stabilized if the quantity of heat received by it from the motor were equal to the quantity lost by radiation from the circuit consisting of crankcase, pumps, and tank. Such an equilibrium cannot usually be maintained because the calorific flywheel formed by the oil mass is not constant but decreases at the rate of 6 to 9 liters (1.59 to 2.38 gal.) per hour for a 500-hp. motor. It therefore becomes necessary in a number of cases to employ a radiator so as to produce a more intensive cooling. The variability of the oil makes its cooling more difficult than that of water. At low temperatures it is apt to stick to the walls of the radiator and retard circulation. At high temperatures the turbulence that is so important for heat diffusion may not be present at all. On the other hand, the oil radiator is much smaller than the water radiator as it has to handle less fluid. Various conditions have led to the preferential adoption of an oil radiator independent of the water radiator and the use of tubes or laminations in the radiator construction. The proper location of the radiator is in the part of the circuit which is not under pressure and in a place where leaks can be easily discovered. It is very important to have the radiator easily accessible, as experience has shown that it gets dirty easily. It is very desirable to make it so that it can stand an excess of pressure such as may be created when starting the motor with the oil cold. For good performance the lubrication must be so arranged that the oil can be heated quickly to the normal temperature, which should be between 50 and 70 deg. cent (122 and 158 deg. fahr.) at the exit from the motor.

The author describes a type of automatically controlled radiator and also deals with the cleaning of the oil and greasing of the motor. (*L'Aéronautique*, no. 126, Nov., 1929, pp. 381–384, illustr., *d*)

Aero Engine Weighing But 0.805 Lb. per Hp.—The Rolls-Royce Schneider Trophy Engine

UNTIL this week the Air Ministry has forbidden the publication of any details concerning the Rolls-Royce "R" engine with which the Supermarine seaplane that won the Schneider Trophy last September and subsequently established the world's speed record of 357.7 miles per hour was fitted. It is now disclosed that the engine develops upward of 1900 hp. and weighs—presumably in the dry condition and exclusive of the radiation system—1530 lb. Its weight is therefore 0.805 lb. per hp., a figure which not so long ago would have been regarded as being outside the bounds of attainment. The engine measures 50 in. in length and 30 in. in width. Great as was the speed realized by the Supermarine machine, it is stated that the engine was capable of giving it a still higher speed, but was prevented from doing so by the fact that the airscrew was unable to absorb all the power of the engine. It is understood that the machine and its engine are shortly to be used for fresh high-speed tests. The engine has twelve cylinders of 6 in. diameter and $6^1/_2$ in. stroke, and is fitted with a blower for boosting the air supply at ground level and with reduction gearing. The time available for the development of the engine was limited, but close cooperation between the Supermarine and Rolls-Royce companies enabled it to be completed and tested with a considerable margin to spare for trials in flight. Very little trouble was experienced during the test flights, and in particular it was found that the engine possessed the ability to run at slow speeds without plug trouble. (*The Engineer*, vol. 149, no. 3868, Feb. 28, 1930, p. 231, *da*)

Gliding

IN SUBSTANCE the experience of the last ten years has shown that, though the air currents to be found in the atmosphere may not be able to meet the needs of aircraft for transport, they are sufficient to allow a wide range of flying without mechanical assistance. As now practiced, gliding and soaring form a sport in which most of the essential qualities of an airman can be tested, practiced, and developed, and at the same time furnish a practically new line of attack on many scientific and technical problems involved in aviation. Already the results obtained from it are said to have led the way to obtaining results from airplanes with low engine powers which formerly required high powers. In addition, however, to the effect of the knowledge gained in these flights on the design of light airplanes, many authorities, including Dr. Georgii, regard the effect of practice in gliding and soaring as highly beneficial in the training of airplane pilots. The operation of this form of flying depends on utilizing the energy of natural air currents which may be set up by the presence of hills and other topographical variations of contour, of clouds, of temperature differences, and by other causes. Prolonged flights are usually performed, and considerable altitudes may be attained, by recognizing the presence of such currents and traveling by them to a higher altitude, shifting on to some other current when the first gives out, or is not in so favorable a direction for the intended flight, and so on. It is expected that readiness to detect these currents and their changes, familiarity with the circumstances and causes of their occurrence, and judgment of the likelihood of their presence or disappearance, will constitute a weather sense, which the practice of gliding will teach pilots intensively, giving them more experience in a flight of 100 km. from hill to hill and from cloud to cloud than in a year's flying on power craft. The experience by which the range of non-mechanical soaring has been enlarged to the remarkable extent illustrated above has shown that wind and weather are rather tools with which skilled pilots will improve their travel than forces of which they should be afraid. There is doubtless a further technique required in power flying, but it is held by many that gliding and soaring experience will do much to provide what is most essential, apart from the occasions, such as the transalpine service, when familiarity with current in such regions has been of direct advantage to airplane pilots. It is thought, in fact, that gliding and soaring stand to power flying in something of the relation that exists between sailing and steam experience, and on this view may become a desirable or even a necessary part of a power-plane pilot's training. Whether this will turn out to be so is a matter of aviation technique which probably will not take long to decide. Meanwhile German aeronauts must be congratulated on

the brilliant results they have obtained in the face of what was far from an encouraging prospect. (From an editorial in *Engineering*, vol. 129, no. 3345, Feb. 21, 1930, pp. 259–260, *g*)

ELECTROMETALLURGY

Electrodeposition of Iron

DURING the World War the British Army repair shops extensively used electrodeposition of iron in an attempt to salvage worn parts of automotive machinery. The method involved the use of a cold ferrous ammonium sulphate bath at low current density. The Westinghouse Research Laboratory in this country has carried on a considerable amount of research since then and has established certain practices which give quite successful results. The following is reproduced verbatim from the original paper.

"In order to test fully the working qualities of deposits produced by these methods, we have built up worn or undersized parts of many kinds, which have then been put in service. These run all the way from the badly scored bearing of a $^1/_{20}$-hp. motor shaft to an experimental airplane-propeller hub, including both the bearing and pinion fit on a street-railway-motor shaft. Plug and thread gages have been repaired and have given good satisfaction, although they are not as hard as heat-treated tool steel. It is of course possible to carburize such pieces, when they will compare favorably with the original gages. One of our prize exhibits is the shaft from a 3-hp. motor which was used on a six-spindle drill press with a rather short, very tight belt. This shaft was ground undersize to simulate wear, then plated with a hot-bath method, ground, and assembled. It ran steadily on the day shift for eight months, and was then taken out for inspection. No wear could be detected, either by micrometer or appearance. As this shaft had had about a thousand hours of actual service, it is quite evident that this material is all that can be desired for bearing service. The press-fit tests, severe bending and forging pieces with coatings $^1/_{16}$ in. or more thick, all indicate that platings produced in this manner are perfectly anchored to the parent metal." (Monthly Review of the Electroplater's Society, December, 1929; paper by T. P. Thomas, Pittsburgh, Pa., abstracted through *The Metal Industry*, New York, vol. 28, no. 2, Feb., 1930, pp. 74–75, *p*)

ENGINEERING MATERIALS (See Machine Parts: Higher-Quality Locomotive Forgings)

FOUNDRY

Oxygen-Enriched Air for Cupola Blowing

THE question of using oxygen-enriched air in various metallurgical processes is an old one. The generally accepted conclusion is that a slight enrichment would produce beneficial results technically, but that its commercial introduction depends primarily on the cost of making the oxygen. In this case an extensive test of a cupola was undertaken. The cupola is part of the foundry of the Gutehoffnungshütte Company and has an inside diameter of 900 mm. (36 in.) and an outside diameter of 1400 mm. (56 in.). The blast is supplied by a blower with a capacity of 100 cu. m. (3530 cu. ft.) per min. The article is a very extensive one, and reports in detail both the conditions of operation of the cupola without air enrichment and the results of the enrichment, as well as the details of making the test.

Five main series of tests were carried out with enrichments of 1.36, 2.04, 2.87, 3.21, and 4.46 per cent of oxygen, respectively. Material results in the way of increase of melt and reducing the fuel consumption were obtained even with the lowest degree of enrichment. They reached their maximum at 2.87 per cent oxygen enrichment, and then began to fall off. At 2.87 per cent there was a decrease in coke consumption of 17.43 per cent as compared with the consumption when there was no enrichment. There was also an increase in output of 46.93 per cent. The author explains both of these in the following manner: The output and the fuel efficiency of a cupola are at a maximum when combustion takes place rapidly and completely, and the heat developed is given up to the metal without excessive losses. Heat losses in an ordinary cupola are due to the fact that some of the carbon of the coke burns to carbon monoxide and not to carbon dioxide, and some of the carbon dioxide in flowing through the coke is converted into carbon monoxide. This seems to be

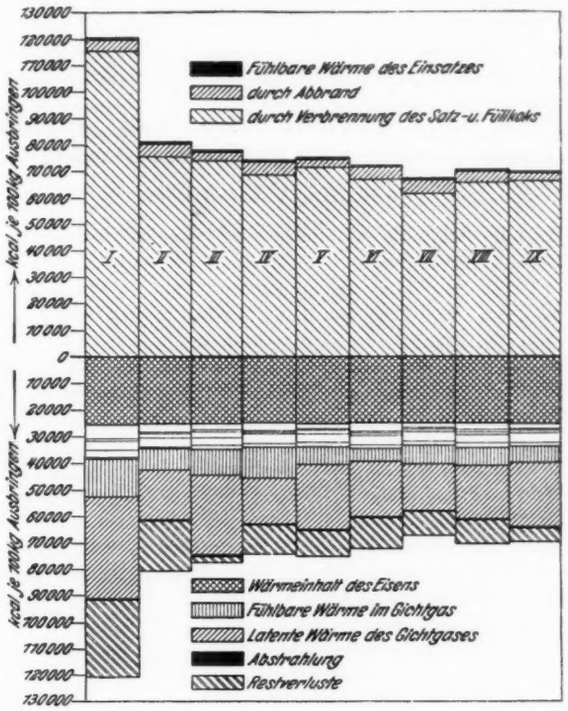


FIG. 1 HEAT BALANCE OF TESTS ON CUPOLA WITH OXYGEN-ENRICHED AIR

(*Fühlbare Wärme des Einsatzes* = sensible heat of the charge.
durch Abbrand = loss through oxidation
durch Verbrennung des Satz-u. Füllkoks = loss through combustion of the heating and charging coke
Wärmeinhalt des Eisens = heat content of the iron
Fühlbare Wärme im Gichtgas = sensible heat in the waste gases
Latente Wärme des Gichtgases = latent heat of the waste gases
Abstrahlung = radiation losses
Restverluste = residual losses
kcal je 700 kg. Ausbringen = kg-cal. per 100 kg. of output.)

true notwithstanding the fact that the process of combustion of the coke in the cupola has not yet been completely explained and it is not known whether the coke burns first to carbon monoxide or to carbon dioxide, or to both at the same time. It would appear, however, that at the beginning of the reaction, carbon dioxide is largely formed. This reaction is strongly exothermic and is followed by a secondary reaction between the carbon dioxide and the carbon of the coke. This reaction, on the other hand, is endothermic and imposes a limit to the extent of the hottest zone.

A series of tests were carried out in the present instance and the results are given in the original article in the form of diagrams and curves, of which Fig. 1 is here reproduced.

The author discusses next the influence of the enrichment on the metalloids, including silicon and manganese.

The tests have shown that the heat consumption per 100 kg.

(220 lb.) of iron is 2298 large calories (9118 B.t.u.) less than the heat consumption without oxygen enrichment. An additional test with air enrichment where anthracite was used instead of coke has shown that that fuel is still unsuitable, as it is too soft.

In the original article an extensive calculation of the economic side of air enrichment is given, from which it would appear that if the cost of oxygen is 5 pf. per cu. m. (3.37 cents per 100 cu. ft.) the melting costs with enrichment are higher than without enrichment. On the other hand, it would appear that a price of 1.47 pf. per cu. m. (1.0 cent per 100 cu. ft.) constitutes the limit of comercial economy where enriched air can be applied, and in order to make enrichment a commercial success the cost of oxygen must be brought down below 1.47 pf. Lürmann and Linde have stated, however, that oxygen can be produced at a cost of 1 pf. per cu. m. (0.67 cent per 100 cu. ft.). (Friedrich Morawe, Oberhausen, in *Die Giesserei*, vol. 17, nos. 6 and 7, Feb. 7 and 14, pp. 132–136 and pp. 155–167, 26 figs., *eA*)

FUELS AND FIRING (See also Foundry: Oxygen-Enriched Air for Cupola Blowing)

The Heating Value of Wood

THE following table contains heating values of air-dried woods in B.t.u. per pound.

Wood	B.t.u. per lb.	Wood	B.t.u. per lb.
Ash	5450	Oak, live	5460
Beech	5400	Oak, white	5400
Birch	5580	Oak, red	5460
Cherry	5420	Pine, white	6830
Chestnut	5400	Pine, yellow	6660
Elm	5400	Poplar	6660
Hemlock	6410	Spruce	6830
Hickory	5400	Walnut	5460
Maple, hard	5460	Willow	6830

(*Power Plant Engineering*, vol. 34, no. 3, Feb. 1, 1930, p. 173, *p*)
[The table published in *Power Plant Engineering* for Jan. 1, 1930, p. 5, not reproduced in the Survey, is incorrect.—EDITOR.]

Pulverized Petroleum Coke as a Fuel

THIS refers to the practice of the Lincoln Beerbower Station of the Oklahoma Gas and Electric Company on the Arkansas River, where petroleum coke from the oil refineries is used as a fuel. Only the first 15,000-kw. turbine-generator unit has been installed as yet. The coke has a heating value of about 14,000 B.t.u. per lb., is free burning, and has a low inherent moisture. It does not appear that any trouble was encountered, as very little about the method of burning this fuel is given in the original article.

Ashes from each boiler furnace pass into a sluice hopper, where they are quenched by five $^1/_2$-in. water jets on each side. During periods of removal, oscillating nozzles at both ends of the hopper wash the ashes into a trench to be flushed along, by water from a trench nozzle, to a storage pit located between the boilers. Through 6-in. lines two ash pumps remove the ash from the storage pit and discharge it to sections of the yard that require filling.

For the present, two boilers have been installed, each having 12,780 sq. ft. of boiler heating surface and rated to deliver 150,000 lb. of steam per hr. at 400 lb. pressure and a total temperature of 750 deg. fahr. On boiler surface alone the foregoing capacity would mean operation at 400 per cent of rating. Some assistance, however, is given by water surface lining the side walls of the furnace and that portion of the rear wall not occupied by a radiant superheater. This surface consists of bare tubes of 3 in. diameter on spaced $3^1/_{16}$-in. centers, all connected into the boiler circulation. The furnace front walls are air cooled. One boiler is able to supply the steam required by the turbine unit. With the installation of a second machine, another boiler will be added, so that one boiler always may be held in reserve. At a steaming rate of 150,000 lb. per hr., a heat release of 25,000 B.t.u. per cu. ft. is obtained. Two 4-ton pulverizers per boiler supply fuel to the furnace through two horizontal, low-velocity, turbulent-type burners.

The original article contains a diagram showing the condensate and feedwater system. To keep the water in the tank from absorbing oxygen, a flat steel float of tank diameter is placed on the surface of the water, and the upper portion of the tank is blanketed with steam, thus eliminating the need for a deaerator.

The main feature of the condensate system is a recirculating line through which a portion of the condensate after passing through the air coolers may be returned and sprayed into the condenser for cooling. This provides an increased quantity of condensate in case its temperature on either light or heavy loads becomes too high to cool the generator air. (*Power*, vol. 71, no. 10, Mar. 11, 1930, pp. 384–387, *d*)

HYDRAULIC ENGINEERING

Cavitation in Hydraulic Turbines

CAVITATION is particularly serious in hydraulic turbines of the reaction class, especially the modern type of high-speed unit operating on low falls. It not only affects the power output but also apparently causes corrosion. It is caused primarily by the fundamental property of water that causes it to evaporate at a sufficiently low pressure even when the temperature is quite normal. If the outer pressure drops to the vapor pressure corresponding to the momentary temperature of the water, a formation of bubbles will result which may set up intensive corrosion.

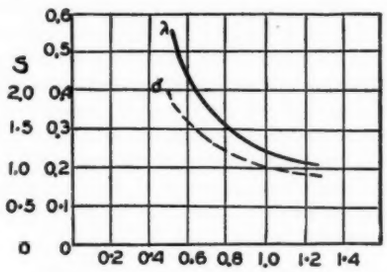


FIG. 2 VALUES OF S, THE CAVITATION INDEX, AND λ, THE MINIMUM-PRESSURE-VALUE COEFFICIENT, AS FUNCTIONS OF RATIO OF BLADE LENGTH TO PITCH, L/T, FOR A SPECIFIC SPEED OF ABOUT 600

The author discusses the mechanism of cavitation with particular reference to the influence of blade shape.

In modern turbines there is a conflict of conditions. On the one hand, small surfaces are employed to reduce friction at high speeds, and on the other hand, the presence of the cavitation phenomenon would seem to require large surfaces.

By extending blades, "channels" are again formed and thus the older wheel form is approached, the local vacua disappear, the admissible values of the cavitation index S become smaller, and the danger of cavitation is diminished. For a certain high speed corresponding to a specific speed of approximately 600, the curve in Fig. 2 is obtained, with S plotted against the L/T value, which shows that the extension of the blades is effective at first but less so later. There is a limit, therefore, to the length of blade which can be conveniently used. That the local vacua become large with small blade surfaces is also seen when the axial thrust of the water (approximately equal to the head multiplied by the wheel surface) is distributed over the blades, which of

course have to carry the head, resulting in higher specific pressure for smaller surfaces. But such blade surfaces take up forces not only through the action of pressure on the concave side but also through the action of vacuum on the convex side. This makes it clear that the vacuum increases with diminishing surfaces and equal total load.

The British Admiralty published in 1917 a report on the corrosion and erosion of ship propellers. From calculations made

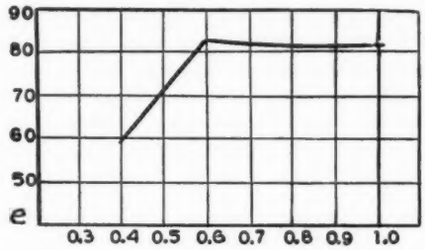


FIG. 3 EFFICIENCY OF A KAPLAN TURBINE WITH FIXED-RUNNER WHEEL AND GUIDE BLADES AS A FUNCTION OF S, THE CAVITATION INDEX

in connection with this report it appears that the pressure produced by the water-hammer action on the blades is independent of the size of the cavity and depends only upon the rate of its contraction. Hence the cavities causing the erosion may be large and small. The cavitation will produce erosion only when accompanied by conditions which will cause the cavities to collapse in such a way and in such a position that the energy of the

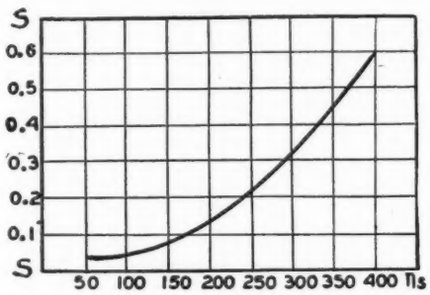


FIG. 4 LIMIT OF VALUES OF S, THE CAVITATION INDEX, FOR FRANCIS TURBINES, ACCORDING TO THOMA

collapse is concentrated on a small proportion of the blade surface.

In support of this water-hammer theory it has been found that in turbines the first visible sign of cavitation is that some spots on the blades get a silvery surface which seems to arise from hammering, and these spots have at later inspections shown the worse effects of erosion.

The cavitation depends on a number of factors. A high suction head will cause trouble, and therefore a propeller-type turbine is generally unsuited to a horizontal setting.

Furthermore, the velocity head regained in the suction pipe has also been considered, as the greater it is the greater is the reduction of pressure on the back of the blades. It must therefore be kept as low as possible by amply dimensioning the runner. The length of the blade in the direction of flow compared with its pitch is also a factor. High-speed runners have a short blade length as compared with the pitch to reduce friction. This, however, leads to a greater specific pressure on the blades, which increases the danger of cavitation. Cavitation depends also on such factors as the shape of the blade, the peripheral speed of the runner, the temperature of the water, etc. With the object of studying the problem, Messrs. Escher, Wyss of Zurich, to whom the writer is indebted for the data upon which these notes are based, and the Verkstaden Co., of Kristinehamn, have erected a special laboratory testing plant, and the latter is described at some length by Elov Englesson in *Engineering* of April 16, 1926. By means of organized tests an efficiency curve can be furnished for different S values by varying H_0 and H_{dyn}.

Fig. 3 illustrates an example in which the efficiency rapidly decreases below $S = 0.6$ owing to cavitation. With this wheel the minimum value of S should not be less than 0.8. If the S values ascertained by experiment are plotted for different types characterized by their specific speed, a curve is obtained which gives a good indication of the limits of application. Fig. 4 illustrates such an S-curve according to Herr D. Thoma of Munich, who has done much to bring light to bear upon the matter of cavitation. This curve represents the present limit values for S which should not be exceeded. At the same time, the value of such curves is limited: they have a similar character to the yield point of metal in that under certain conditions they may vary considerably due to circumstances. (F. Johnstone-Taylor in *Power Plant Engineering*, vol. 34, no. 4, Feb. 15, 1930, pp. 236–238, 3 figs., *geA*)

Large Jet Dispersers at Arapuni

AT THE Arapuni hydroelectric power plant in New Zealand a remarkable case of heavy erosion has been encountered, necessitating special protective machines. There have been several heavy falls of rock. To deal with this situation and relieve the flow over the spillway a tunnel has been excavated and a pipe line completed, but instead of being connected to turbines they each have a Glenfield energy disperser fitted at the lower end, Fig. 5. By these means 3000 cu. ft. of water will be passed down each of the two penstocks per second, and the energy of the escaping jets amounting to nearly 50,000 kg. will be destroyed by air resistance due to the action of the disperser and will be laid harmlessly on the river surface in the form of heavy rain. These dispersers produce a free vortex motion in the escaping jet, which causes complete disintegration and dissipates the destructive energy, and falls over a large surface entirely devoid of shock.

The New Zealand Public Works Department have had previous experience with the Glenfield jet disperser in connection with the discharge from the Mangahao dam, where the rate of discharge is 700 cu. ft. per sec., which is equivalent to 20 tons of water per second and the harmless dissipation of 5000 continuous shock horsepower.

It may be remarked that the problem of dissipating the energy possessed by high-velocity water is essentially a modern one and is the direct result of experimental work on scale models combined with some 150 photographs with 0.001 sec. exposure, undertaken by Glenfield & Kennedy, Ltd., of Kilmarnock, in their hydraulic-research laboratory

This research was originated to find a solution for overcoming the destructive action experienced with the powerful streams of water emerging from the bottom outlets of the high-head dams of current practice.

Dangerous jets are now released with impunity under many circumstances hitherto thought impossible.

We may say that the evolution of this device is a classical step in the study and application of a very old law in hydraulics, and its deliberate application to form a free vortex in large and powerful jets is an entirely novel idea, and for the first time employs the correct principle for the efficient disintegration of a solid jet.

For those who are not familiar with the action of this disperser, we may explain that fixed guide vanes are placed in the disperser, which in turn is attached to the discharge end of a culvert or pipe. (Fig. 5.)

These guide vanes conform to the law of a free vortex as dis-

covered by Giovanni Battista Venturi (1746–1822) in the account of his experiments on fluid motion (1791), in which he established the law that every small element of fluid across a free vortex rotates at a uniformly increased speed as it approaches its center, the velocity of rotation being inversely proportional to the radius of the jet or $V = l/r$.

The jet leaves the disperser as solid water, and under this rotation literally bursts into drops against the air resistance.

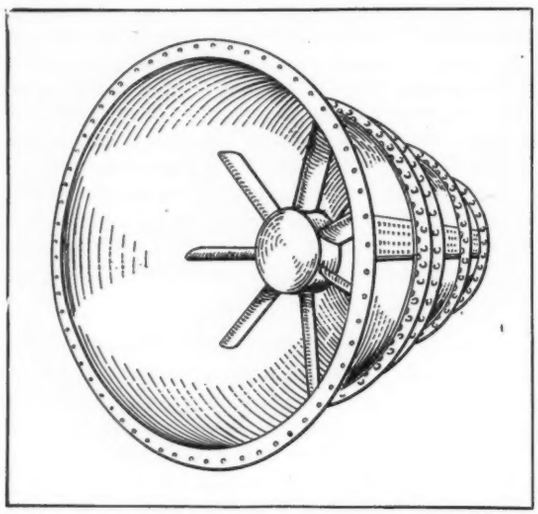


FIG. 5 GLENFIELD DISPERSER ERECTED AT THE ARAPUNI HYDRO-ELECTRIC POWER PLANT IN NEW ZEALAND

On the release of the free vortex, each filament of water pursues a straight-line course determined by its axial velocity and its tangential twist, the greater tangential velocity of the central filaments causing them to take a more divergent course than those remote from the axis. The result is that the inner currents tend to pass through the outer currents, and the released jet becomes an expanding cone of interlacing filaments of fluid and is rapidly disintegrated throughout its bulk into drops of uniformly small size. These tiny globules of water as they are thrown out offer an enormously increased surface to the resistance of the atmosphere, and the whole energy of the jet is most effectively absorbed by an air cushion of practically unlimited dimensions. The drops thus cushioned are scattered over a large area, which is fed by a steady increment of gently falling water, thereby creating a uniform onward current over the whole discharge area, entirely free from swirls and incapable of causing damage in any water whatever. (E. Bruce Ball in *Water and Water Engineering*, vol. 32, no. 374, new series, Feb. 20, 1930, pp. 80–81, 3 figs., *d*)

INTERNAL-COMBUSTION ENGINEERING

A High-Speed Single-Cylinder Gas Engine

THE article here abstracted tells how step by step, by the employment of a series of artifices, the speed of a $13^1/_4 \times 16$-in. single-cylinder engine was raised from the original 250 r.p.m. to 500 r.p.m. without setting up bearing pounding or vibration. Only the most significant features of the story can be retold here.

In the first place, every effort was made to reduce the weight of the reciprocating parts. This was first done by the employment of an aluminum piston, but later on return was made to a cast-iron piston lightened in the barrel. Next, a lighter connecting rod was installed. Then a piston with a thin section through the head was experimented, but this caused backfiring.

The matter of compression pressures was then taken up, with the result that a high-compression head was ultimately developed that permitted the engine to run very much faster than at low compression without knock. The new piston head was next installed, and experiments indicated the proper location of the spark plug to meet the existing conditions. With this done the engine showed good performance up to 370 r.p.m., and no pronounced knock was detected up to a speed of 410 r.p.m.

However, to be satisfied that all possible has been done, L. H. Morrison (Mem. A.S.M.E.), of New York, was called in to make a study of the engine. He went to the factory and saw the engine under actual running conditions.

His report bore out, from a technical standpoint, the results of the experiments. It was decided to follow one more of his recommendations. This was the installation of a pressure-

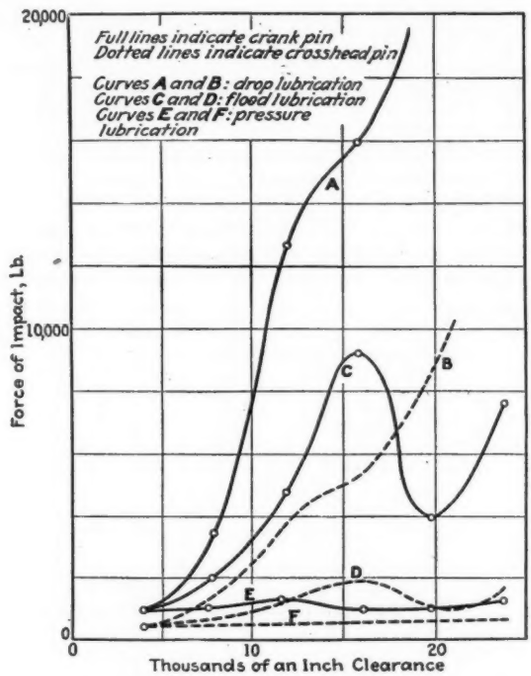


FIG. 6 BEARING IMPACT WITH DIFFERENT TYPES OF OILING

oiling system for the crankpin and the crosshead pin. It was argued that the pound was the result of the pressure changing from one side of the bearing to the other. The knock was caused by the hammer blow delivered when the two parts, the bearing and pin, came into contact. If there were no clearance there would be no pound, and if oil were introduced into the clearance at the proper pressure the mechanical clearance would disappear and pounding would be eliminated. Tests on a uniflow engine, recorded in Fig. 6, indicated that the argument was valid, for it will be observed that the impact blow with pressure feed is far under that with gravity feed.

A pump was constructed to furnish oil at 50 lb. pressure to the main bearings, the crankpin, and the crosshead pin. With this oiling system, speeds in excess of 500 r.p.m. or 1350 ft. per min. piston travel have been attained without any knock of consequence being noted.

The crankshaft is drilled so that oil flows from the main bearing to the crankpin, and the connecting rod is drilled so that the oil passes through the rod head to a copper tube which carries the oil along the outside of the rod to the crosshead end, where it again enters the rod and flows to the crosshead pin.

It is definitely proved that pressure lubrication permits the operation of the engine at an overload on the properly balanced rotating and reciprocating parts which otherwise could not be handled without serious detriment to its life and operation. Specifications of the engine and line drawings showing the original and modified designs are given in the original article. (Geo. L. Reid, of the Joseph Reid Gas Engine Co., in *Power*, vol. 71, no. 12, Mar. 25, 1930, pp. 466–468, *ed*)

The Vulcan Coupling for Geared Diesel Engines

THE Diesel engine has two disadvantages: (1) Uneven torque and hence torque fluctations which necessitate a particularly heavy section of the shaft driven by the Diesel engine; and (2) the large size, heavy weight, and sensitiveness to heat stresses of the large cylinders of Diesel-engine units for large outputs.

As to the second, it is known that the use of gearing permits splitting up the power of one large unit into two or more small high-speed light units whose small cylinders are much less sensitive to heat stresses. The effect of torque fluctations can be counteracted by a proper coupling of the Diesel engine to the driven shaft, and the Vulcan gear with its hydraulic coupling has been designed for this purpose.

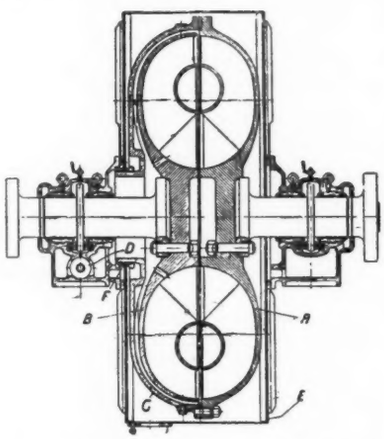


FIG. 7 VULCAN COUPLING FOR GEARED DIESEL ENGINES

In marine propulsion the Vulcan gear permits the use of Diesel engines whose revolutions are a great deal higher than those of the propeller shaft. The original article shows two peak-load Diesel generating sets of 15,000 kw. each. They drive one generator with a double Vulcan gear. Each engine is entirely independent of the other and can be cut in or cut out at will while the set is running, which makes it possible at smaller loads to use only one Diesel engine running at full or nearly full load.

The Vulcan-gear Diesel generating set can be used also as a phase corrector. As soon as the Diesel engines have brought the generator up to normal revolutions, they can be at once uncoupled and the generator run alone as phase corrector.

A typical Vulcan coupling is shown in Fig. 7, and, as will be seen, it consists of two wheels of cuplike section arranged opposite each other. *A* is the driving wheel, *B* the driven wheel, and *C* is the cover bolted to *A* and encompassing *B*. The driving fluid is contained in the cups of *A* and *B*. The clearance between *A* and *B* varies from 5 to 15 mm. (roughly $^1/_4$ to $^5/_8$ in.), according to the size of the coupling, so that there is no metallic connection between *A* and *B*, and it is not necessary that *A* and *B* are exactly in line. The cuplike section of the driven or driving wheel is divided into a large number of cells by means of radial vanes. Rotation of the driving wheel causes the fluid in its cups to flow to their outside periphery. From here, as the driven wheel is yet stationary, the fluid flows past the outside periphery of its cups, through them, and past their inside periphery to the inside periphery of the driving-wheel cups, and from there back again to their outside periphery. In other words, the fluid starts on a circulatory motion between the cups of driving and driven wheel. As in doing so it passes from the vanes of the driving to those of the driven wheel, it starts to set the driven wheel in motion. Since even when the driven wheel has attained full speed the load on it causes it to lag behind the driving wheel, the centrifugal forces in the driving wheel are always larger than those in the driven wheel, so that the circulatory motion of the fluid from the driving to the driven wheel is always kept up, and thus the transmission of power from the one to the other.

The cover *C* prevents the fluid from being driven out of the coupling, because any fluid entering the space between *B* and *C* through the clearance between *A* and *B* would, in order to escape at *D*, have to overcome the centrifugal force which tends to drive it to the periphery of the coupling, which, of course, it cannot. As the difference in revolutions between *C* and *B* is not more than the slip, the fluid friction in the clearance *B* and *C* is only very slight. (W. Brose in a paper read before a meeting of the Diesel Engine Users Association, Dec. 13, 1929; abstracted through *Gas and Oil Power*, vol. 25, no. 292, Jan. 2, 1930, pp. 65 and 76, 2 figs., *d*)

IRON AND STEEL ENGINEERING (See Special Machinery: An Italian Three-High Blooming and Slab-Blooming Mill)

LUBRICATION (See also Aeronautics: Circulation of Lubricating Oil in Aircraft Engines; Internal-Combustion Engineering: A High-Speed Single-Cylinder Gas Engine)

Lubricating Oil for Automobiles—Viscosity Effect and Test Methods

THE importance of cold performance of lubricating oil was discussed by W. A. P. Schorman, chief technologist of the British American Oil Company of Canada, at the December 19, 1929, meeting of the Canadian Section of the Society of Automotive Engineers in Toronto.

The oil companies of the United States spent approximately $9,000,000 in 1929, remarked Mr. Schorman, for new equipment in connection merely with the extraction of waxes from lubricating oils, to reduce the present pour test and at the same time keep shear down to normal conditions. He then discussed the properties of the various crude oils and the serious problem of dewaxing. With a series of lantern slides he showed how the different oils behave under varying conditions of friction and temperature, but he maintained that the viscosity of the different oils, no matter of what grade, is exactly the same at the point of transition. Recent experiments have proved this, and he showed a graph illustrating how three different oils reached the transition point at 217, 246, and 260 deg. fahr. but had exactly the same viscosity.

Of particular interest to Canada and the northern sections of the United States is the fluidity of oils. The University of Saskatchewan had placed its facilities at his disposal on a recent visit, and he had been able to conduct a series of tests under sub-zero conditions. The engine would start quite readily on one oil, S.A.E. 10, at 12 deg. below zero at 315 consistometer shear; with

a crank it would start at 470 shear, or at —22 deg. A second oil would give normal starting at not less than —5 deg., while a third would make normal engine starting possible only at 8 deg. above zero. One naphthene-base oil which met a pour test at —18 deg. did not, as a matter of fact, make starting possible below —15 deg. with a normal battery.

Present A.S.T.M. methods will have to be revised, the lecturer contended, especially with respect to the cold test. One man sent a sample of oil from Oklahoma which was guaranteed to stand a pour test at 35 deg. below zero, but at —12 deg. was so viscous that it took a service station an hour to empty a one-quart bottle.

In reply to a question, Mr. Schorman said that, while in Saskatoon, he drove for 10 miles or so one day with the temperature at 26 deg. below zero, stopping a few minutes here and there, driving for half an hour, and stopping again, keeping within the speed limit. The maximum temperature the crankcase registered was +3 deg. Under these circumstances, he commented, as much as 50 per cent of the power of the engine was consumed by the shearing of the oil. On the following day, at 25 deg. below zero, a trip of 104 miles was taken, reaching a speed of 45 m.p.h., and under these conditions the temperature in the crankcase increased just 100 deg., or to 103 deg. This showed that for cold-weather driving, shear materially affects the car performance. (*S.A.E. Journal*, vol. 26, no. 1, Jan., 1930, p. 12, *pg*)

MACHINE PARTS

Higher-Quality Locomotive Forgings

MANY of the higher-quality forgings are made by reheating cooled ingots and forging them to billet form under a steam-hydraulic press, by means of which, with a sufficiently small ingot, the forging can be produced by one operation direct from the ingot. Specifications are now drawn in a manner to provide a reduction of not less than three to one from ingot to forging, which carries the advantage that in the larger driving axles and connecting rods required for modern locomotives, locomotive manufacturers do not have to employ abnormally large ingots in which there may be excessive secondary segregation. The major portion of locomotive forgings being employed at the present time are constructed of one of the five types of steel, viz., plain carbon steel, which is quenched and tempered, carbon-vanadium steel normalized and tempered, plain carbon steel normalized and tempered, chromium-nickel steel quenched and tempered, and chromium-vanadium steel quenched and tempered. The chromium-nickel steel and the chromium-vanadium steel are not very extensively used, and where they are, their use is confined chiefly to special conditions of high stresses or high factor of safety. The present tendency is toward steels which will produce good physical properties when normalized and tempered, and to get away from quenched and tempered forgings. Typical specifications of the present require tensile properties of from 15 to 25 per cent greater value than those required a decade ago. The high yield and strength ratio of normalized and tempered carbon-vanadium steel forgings, with a carbon content of from 0.35 to 0.45 per cent, vanadium around 0.18 per cent and manganese 0.75 per cent, is due to the manganese content, while the vanadium causes ample grain refinement and consequent ductility. Excellent results are obtained with this steel when it is clean and well made, and handled properly in forging.

At the present time the five elements, silicon, manganese, phosphorus, sulphur, and carbon, constitute the list of materials that are capable of being covered by a chemical specification for carbon steel. Notwithstanding the fact that they are important in ascertaining the strength and solidity of the steel, they do not completely measure its quality. This fact places the making of steel in the list of arts and not of sciences. In addition, when the steel is made, a properly made heat and an improperly made one may possess the same composition in so far as the five elements are concerned and may be incapable of being distinguished apart from each other through common methods of routine chemical analysis; still, in service it is possible for one heat to render good and the other unsatisfactory service. It is necessary that a highly skilled and thoroughly conscientious steel maker govern the supply sources. (W. J. Knight in *The Railroad Herald*, vol. 34, no. 3, Feb., 1930, pp. 27–29, *g*)

MACHINE-SHOP PRACTICE (See also Electrometallurgy: Electrodeposition of Iron)

Machining Aluminum and Its Alloys

TOOLS used on brass or steel are not satisfactory for machining aluminum. The most important requirement for this purpose is the cutting angle of the tool. In fact, tools similar to those used in cutting hardwood come nearer to satisfying the requirements in machining aluminum. The ranges of cutting angles for various materials are shown in Fig. 8. The cutting

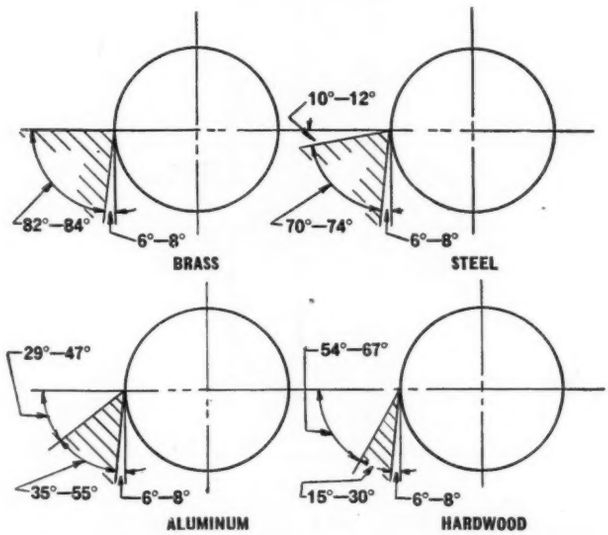


FIG. 8 RANGES OF CUTTING ANGLES FOR LATHE TOOLS

edges of the tools must be keen and smooth, and to insure this the final grinding of the tool should be done with fine-grained wheels supplemented by stoning with a medium or fine-grade carborundum stone. When stoning by hand, care must be used to see that no wire edges or burrs remain on the cutting edges.

Tools for machining aluminum should have a front clearance of from 6 to 8 deg. and side-rake angles of from 10 to 20 deg. The author shows in the original article a lathe tool suitable for work on aluminum. The chips should not be too curly.

For machining certain alloys of aluminum, notably those containing silicon, tungsten carbide tools are recommended in preference to high-speed steel, although the latter can be also used successfully. If the tungsten carbide tools are used, it is necessary to have machines that are free from lost motion or vibration which might cause chattering. There must be a minimum amount of spring in the tool-bit holder.

Milling cutters, straddle mills, end mills, and similar tools produce the best results in machining aluminum and its alloys when they are of the coarse-tooth spiral or helical type. These cutters,

however, work best when their cutting edges are provided with appreciable top rake. Recently, tools of this type have been placed on the market for use in machining steel. Such tools work quite well on aluminum, but would give still better results if the angles of the top rake and side rake were increased

The threading of aluminum parts can be readily accomplished by the use of spiral taps or taps of the "gun" type. The latter, however, does not give best results when used as a bottom tap or for taper threads. In general, spiral fluted taps, such as shown in Fig. 9, will prove the most satisfactory for use in aluminum. Such taps, however, should be provided with top rakes on the back of the lands so that they will clear themselves when being backed out of the work. High-speed-steel taps with ground, relieved threads give best results.

Oversize taps are often used on aluminum, as they assist in maintaining the required dimensions. That is, aluminum, because of its lower modulus of elasticity has more recoverance

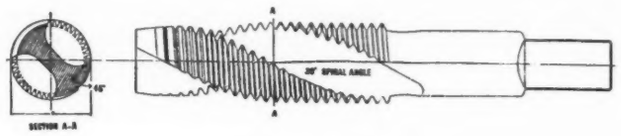


FIG. 9 SPIRAL-FLUTED TAPS

after tapping than steel. Thread chasers for automatic and semi-automatic die heads and for collapsible taps should be ground with considerable side and top rakes. Certain makes of these tools lend themselves more readily than others to this modification of cutting angles.

Ordinary twist drills are not satisfactory. Single-fluted twist drills such as are used in the manufacture of hardwood furniture and two-fluted drills with spiral angles of about 47 instead of the usual 24 deg. may be used. Special drills developed for drilling copper also work well on aluminum. In all cases the cutting edges of the drills should be stoned smooth if best results are expected. In some cases chromium-plated tool bits have shown improvement over similar tools not so plated. (R. L. Templin, Aluminum Co. of America, in *The Metal Industry*, New York, vol. 28, no. 2, Feb., 1930, pp. 67–69, 5 figs., *p*)

MANAGEMENT

The Foreman-Manager Plan at Armco

INDIVIDUALLY the foreman is the head of the smallest operating unit, but collectively he is the most important figure in industrial productivity. There has therefore been in many plants an earnest effort to train the foreman for his job. At the American Rolling Mill Company's plant at Middletown the conference method was formerly used for foreman training, but in 1929 a new plan was evolved and its soundness has been tested by several methods of operation.

Generally speaking, the program is focused on the broadening of the foreman's appreciation of his own responsibilities and improving his job technique. Its foundation is the adoption of three logical premises. The first is that the foreman is a manager. To do his job effectively he must have the managerial viewpoint—must know what is expected of a manager. Second, as a manager, his efforts should be directed at lowering the costs of production. Third, the most important factor contributing to decreased costs is the prevention of waste.

Waste prevention is a big, broad subject. Armco's personnel service staff analyzed the foreman's job from this angle, and were astonished at the regularity with which each of his functions points directly at waste prevention. It encompasses his job. They concluded, too, that because waste occurs every day right under the foreman's nose, its measure being limited by his managerial ability, the prevention of waste would serve as an excellent vehicle to convey the program into the foreman's realm. Another advantage is that the results can be definitely measured by the cost sheet.

Even the title has been changed from foreman to foreman-manager. At the same time it should be borne in mind that Armco's foreman-manager training is not exclusively a waste-prevention program.

The conference method, however, has not been entirely abandoned, but is used as a means rather than the whole. Emphasis is laid upon the actual practice on the job of the points emphasized in the discussion. One month is devoted to each of the subjects considered, and every precaution is taken to quiet the effervescent dangers of a campaign. Earnest sincerity in the pursuit of job knowledge is the goal.

Each subject is first presented by a standard plan. The works manager of each Armco plant assembles his entire supervisory force, usually at a dinner meeting, the first of each month. There the blanket outline of the month's program is described. Every subject is divided by four, a different topic for each week. The last week of each month is always devoted to the study of the cost sheets as affected by that particular subject. At these general meetings no attempt is made to analyze or discuss job technique.

The next step in the operation of the plan is begun when the general superintendent of each plant calls in his department superintendents. These men break down the outline into departmental problems and discuss corrective measures. Such meetings are always supplemented by a review of the previous week's accomplishments.

The department superintendent holds weekly meetings with foremen-managers and leaders. Here also are given weekly reviews of the past week's accomplishment.

After several months of operation some interesting by-products have been observed. For example, department superintendents have also improved by obtaining training on some particular point of weakness, as, for example, failure to understand and read cost sheets intelligently. Another development is the trend toward greater use of the company's service departments, such as cost, betterment, engineering, and personnel service.

The following is given as an example of how the plan works. A processing-department superintendent called his men together and asked them to enumerate the different sources of waste of material in process. They were written down. Then said he: "Bill, you investigate the waste caused by spilled sheets; Henry, this is your subject; Jim, you take bad piling." Every foreman manager was assigned a subject, told to investigate thoroughly all of the causes contributing to that particular kind of waste, and to recommend in writing how the troubles could be cured. These papers are assembled now in one volume. It is a departmental encyclopedia of information, and best of all, each of the foreman managers learned a lot more about his own job than he ever knew before. Their viewpoint is entirely different, to say nothing of their increased interest.

Probably the climax of the results which might be attributed to foreman-manager training, the article continues, is the recent orgy of record breaking in which all plants are participating. After a business depression, it usually requires a certain amount of time for an organization to shift into high gear. However, with the return of a greater volume of orders to the mills in January, the Armco organization began to smash production records immediately. The last edition of the plant newspaper tells of the establishment of 28 new production records.

Having had a good look at the organizational X-ray revealed

by the foreman-manager training plan, the American Rolling Mill Company is now seriously considering the establishment of a standard minimum requirement which men must be able to meet before they can be promoted to supervisory jobs. As is the case in most industries, promotion to the rank of foreman was simply the execution of some one's opinion. If the opinion was wrong and the man not quite "ripe" to assume responsibility, he assimilated the necessary amount of training through the routine of the job and at the expense of production. The minimum requirements which are now being contemplated would sort out those requiring more training as well as those who should never accept supervisory responsibility. (*The Iron Age*, vol. 125, no. 11, March 13, 1930, pp. 777–781, illustrated, *d*)

MECHANICS (See Pipe: Tests on High-Pressure Pipe Bends)

METALLURGY (See Foundry: Oxygen-Enriched Air for Cupola Blowing)

MOTOR-CAR ENGINEERING (See also Lubrication: Lubricating Oil for Automobiles—Viscosity Effect and Test Methods

The Bucciali Front-Wheel-Drive Car

THIS car has been developed by Bucciali Brothers in Paris since 1925. A car was brought over to this country in an effort to interest American manufacturers. One of its unusual features is that the transmission is arranged with its shafts transverse to car frame and the speed-changing mechanism is incorporated in the drive beyond the speed-reducing gear. The clutch shaft carries a bevel pinion which meshes with the bevel gear on a transverse shaft to effect the normal speed reduction between engine shaft and differential. These bevel gears are said to be cut with double teeth, whereby end thrust is eliminated. The impression which this description conveyed to the writer was that the pinion and gear are of the spiral bevel type and that each consists virtually of two gears, with right- and left-hand teeth, respectively. Since the change-speed gears are located beyond the speed-reducing gears, their speed is very much lower than in the conventional car, and this is said to result not only in unusually silent operation but in easy shifting as well.

The ring gear is mounted on a hollow shaft which on one end carries the constant-mesh pinion and on the other a member of a dog clutch for the direct drive. The constant-mesh pinion meshes with a constant-mesh gear on a secondary shaft parallel with the primary shaft and, of course, also extending transversely to the frame. This secondary shaft, in addition to the constant, mesh gear, carries pinions for the first, second, and third speeds-meshing or adapted to mesh with corresponding gears on a transmission drive shaft which is concentric with the driven bevel gear and extends through its hollow shaft. The pairs of gears for the second and third speeds remain constantly in mesh and are controlled by dog clutches. The low speed, on the contrary, is controlled by sliding its pinion along the splined shaft. For the reverse, a reverse idler may be brought into mesh with the pinion and gear of the low-speed set.

The driven shaft of the transmission drives the differential housing. Each side gear of the differential carries one of the axle-shaft stubs, to which is secured a universal joint. There is another universal joint at each wheel, whose center lies in the knuckle-pivot axis. One of the universal joints includes the functions of a sliding joint.

As the front wheels are independently sprung, there is no front axle properly speaking. The rear wheels, which are not used for driving, are also independently sprung and provided with compensators similarly to the front wheels. These compensators each consist of a horizontal cylindrical chamber above the transmission housing, in which there are two pistons located between rubber disks of special shape to increase their deformability. These pistons connect by links to the ends of arms extending upwardly at an angle from the trumpets or flared tubes surrounding the axle shafts. The disks evidently have a damping action.

The car described uses a Mercedes-type SS six-cylinder engine with supercharger. It is stated that in recent years the Bucciali Brothers have been developing a detachable-motor fore carriage which permits of detaching the power unit from the chassis and replacing it by another if desired. (P. M. Heldt in *Automotive Industries*, vol. 62, no. 3, Jan. 18, 1930, pp. 75 and 96, 2 figs., *d*)

The Kerr, Stuart & Co. Diesel-Engine Truck

THIS is a 7-ton truck equipped with a 70-b.hp. McLaren-Benz engine of a type similar to that used for light locomotives built by the same company. Because of the large size of the motor, electric starting was not used. Instead an air-cooled motorcycle engine equipped with a pull starter turns the main engine over by a simple friction gear on the main flywheel.

The truck is in no sense a converted gasoline vehicle, and has obviously been designed, from the first, for its own particular purpose, embodying as it does a number of novel constructional features. Thus, the chassis is constructed of pressed-steel members, having a maximum depth of 14 in., and while it has just sufficient flexibility to "breathe" slightly under stress, it is possessed of such cross-rigidity as never to become permanently distorted under load.

Chain drive and a dead back axle have been chosen, and this has played an important part in the reduction of unsprung weight. The back axle consists merely of a nickel-steel tube, which does not revolve or carry any other stresses than the weight of the vehicle. A saving of some 560 lb. of unsprung weight is thus effected, as a live back axle constructed for the same duty would have weighed approximately 780 lb. Most interesting, however, is the rear suspension, which introduces a principle never before used on any road vehicle. It has been called "Enharmonic" springing, because it makes use of the difference in the natural rates of oscillation of two springs to give a springing system which, while being fully resilient, has a minimum amount of bounce. The two rear springs of the Kerr, Stuart Diesel truck are carried athwart the chassis; one being alongside the rear axle and forward of it, and the other in similar position to the rear. The axle is constrained to move in the arc of a circle by means of the radius rods which are provided. These latter serve to hold the rear wheels at an invariable distance, and to allow of chain adjustment when necessary.

The two springs have the same "rate," i.e., they deflect an equal amount for an equal load—in this case a half-inch per ton—but in action the forward spring will be compressed a lesser distance than the rear one, since the former is nearer the radius-rod center than is the latter.

A spring, when compressed and released, performs a motion known as a simple harmonic motion. This is similar to that made by a pendulum or by the string of a musical instrument, hence the name "harmonic." This motion can be represented by a wavy curve above and below a straight line, which would be the point of rest. The effect of the special arrangement of the Kerr, Stuart springs, whereby one travels through a different distance to the other for a given disturbance of the axle, is to shift the harmonic curves of the two springs out of synchronism. The two springs, for a given deflection, each carry out the same number of oscillations before coming to rest, but these two sets of oscillations before coming to rest, are out of time with one another, and

although, if separate, the individual springs would take quite a little time to come to rest, the two springs acting out of synchronism damp one another very rapidly. (*Gas and Oil Power*, vol. 25 no. 292, Jan. 2, 1930, p. 62, 1 fig., *d*)

PIPE

Tests on High-Pressure Pipe Bends

THIS paper contains a report and analysis of a series of tests on high-pressure pipe bends, supplementing tests previously made on pipes designed for moderate steam pressures.

In the publications listed are given formulas for calculating the deflection of a pipe bend subject to certain external forces, or, conversely, for calculating the forces created in a pipe bend subject to heat expansion in a pipe line of which the bend forms a part. The question of the stresses arising in pipe bends under these conditions, and hence the strength of the bends under the action of given forces and couples, was also fairly cleared up as far as pipes designed for moderate pressures are concerned. In one of the publications it was proposed to use the longitudinal stress in the middle surface as the criterion of strength, and it was found that so long as that stress did not exceed about 20,000 lb. per sq. in., in pipes made of soft steel, lap welded or seamless, there would be no appreciable permanent set as a whole, although local overstrains might exist over limited areas of the surface of the pipe wall in the neighborhood of the most strained section. It was not considered safe, however, to rely on this strength criterion for pipes of relatively greater wall thickness until it had been verified experimentally. The tests described in the present paper were made chiefly for the purpose of clearing up this point.

In these tests Huggenberger tensometers were used in tests of two of the bends. This instrument seemed to give more consistent results than the Berry strain gage.

The tests here analyzed seem to show that the formulas established in previous papers for pipes of moderate wall thickness hold good also for thicker-walled high-pressure pipes. The theory that the longitudinal stresses in the middle surface can be used as a strength criterion seems to apply to high-pressure pipes as well as to moderate-pressure pipes. Again, it was found that so long as the maximum longitudinal stress, tensile or compressive, at the middle surface does not exceed 20,000 lb. per sq. in. there will be no appreciable permanent set in a pipe bend. This rule is expected to hold for all pipes designed for moderate or high pressure, whether lap welded or seamless, of a radius of curvature not less than some four or five diameters, provided also that the material from which the pipes are made is a ductile low-carbon steel or iron of good quality, with a yield point of not less than 25,000 lb. per sq. in.

Although apparently, when the aforesaid stress is reached at the middle surface, the pipe as a whole is within the limit of elasticity, yet it is likely that overstrains will exist locally in certain parts of the pipe and that repeated applications of the same load will in time produce a permanent set. It is recommended, therefore, to design for a substantially lower working stress, say, 16,000 lb. per sq. in. This, then, is the stress existing at the middle surface, but allowance should be made for the compressive stress due to end forces, formula [9], and eventually for the tensile stress due to internal steam pressures, as given by formula [20] in the original article.

$$p_e = \frac{P}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots [9]$$

where P is the force acting at each end of the pipe bend, p_e the longitudinal compressive stress due to the end load, and A is the sectional area of the wall.

The alternative theory for calculating the stresses proposed in chapter F in the original article seems preferable on account of its simplicity, and it should be mentioned that the formulas [11] and [13] in the original article for the longitudinal stress at the middle surface, to be used as the strength criterion, apply in either case.

The question whether the formula and the strength criterion here proposed apply to pipe bends of very short radius of curvature is the object of further research now in progress at the Institute.

On the whole, there is a good correspondence in the character of the curves for observed and calculated longitudinal stresses, but generally the observed stresses are somewhat greater than the calculated. The curves for the observed and calculated transverse stresses show a very close agreement. Among other things, the author investigates whether the material reached the plastic stage in cases represented on the diagrams in the original article where the bends as a whole were within the limit of proportionality. Theoretically, the metal should not have began to flow until the value of "equivalent" stress reached the yield point. Actually, it is found that the equivalent stress does not much exceed 20,000 lb. per sq. in. except in one case. Hence, there should be no flow of the material in any of these cases, but since it did actually occur, the most plausible explanation seems to be that the material was under an initial strain probably produced in the process of bending.

Accepting as a fact that the plastic state was actually reached locally in certain regions, one can explain the discrepancy between the calculated and observed longitudinal stresses in case of the 8-in., 10-in., and 12-in. pipes, but this explanation fails in case of the 6-in. pipe. Here the permanent strains were supposed to be eliminated by taking the strains relative to the reference load applied immediately after the load in question, and yet the observed longitudinal stress at the top of the section was up to 100 per cent in excess of the calculated stress. A reasonable explanation of this discrepancy seems to be the interaction between the plastic parts and the surrounding elastic regions, which latter exert a restraining influence on the former. It must be borne in mind that in the present case incipient plasticity probably does not extend much below the surface of the pipe, because the transverse stresses decrease rapidly toward the middle surface.

An interesting part of the paper dealing with permanent strains and strain lines cannot be abstracted here because of lack of space. The same applies to the section devoted to stresses due to steam pressure. (William Hovgaard in the *Journal of Mathematics and Physics, Massachusetts Institute of Technology*, vol. 8, no. 4, Dec., 1929, pp. 293–344, 27 figs., *te*)

POWER-PLANT ENGINEERING (See also Fuels and Firing: Pulverized Petroleum Coke as a Fuel)

A Flash Heat Exchanger

IN MANY plants there are large quantities of high-temperature liquids, the heat of which is wasted because the liquid cannot be passed through heat exchangers. This may be, for example, because the liquids contain solids in suspension which would quickly plug up the ordinary heat exchanger. Paper mills are an instance of such plants. Lately a new method has been developed which utilizes the principle of flash evaporation. Water and pure vapor only are used in the heat-transfer apparatus, and the heat exchange takes place in a direct-contact heater so that there are no tubes to be kept clean or to leak.

Fig. 10 illustrates a simple arrangement of this heat-exchange system. A flash chamber is connected to a direct-contact heater

equipped with a steam-jet air pump. The digested or cooked pulp enters the flash chamber at the top and is spread out automatically, providing sufficient free area for the necessary vaporization. The steam-jet air pump attached to the direct-contact heater maintains a vacuum within the system. Steam from the hot, pulp-filled liquid is flashed off and passes to the heater.

Raw water fed to the process passes first through the after-condenser of the steam-jet air pump, absorbing the heat of the steam used to maintain the vacuum. The feedwater is then sprayed into the heater where it comes into direct contact with

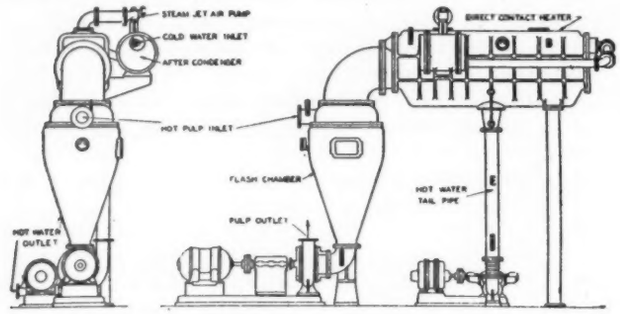


FIG. 10 SINGLE-STAGE FLASH-TYPE HEAT EXCHANGER FOR PAPER MILLS

the steam and absorbs the latent heat of the steam flashed from the pulp. It is thus possible to heat the feedwater to a temperature within a few degrees of the temperature corresponding to the vacuum in the heater. The mixture of raw water and condensate flows down the tail pipe of the heater to the suction of the raw-water pump which delivers it to the process. The pulp within the evaporator, after being cooled to the temperature corresponding to the vacuum by generation of flash steam, flows into the suction of the pulp pump. This pump delivers the pulp to the next step in the process.

In this system, if the amount of raw-water feed is equal to the amount of pulp flowing through the process, approximately 40 per cent of the fuel necessary to raise the temperature of the pulp from an inlet temperature of 50 deg. to a desired temperature of 200 deg. fahr. would be conserved.

An increased saving in heat may be accomplished by the adoption of two or more stages. The increased number of stages has the same effect as a counterflow arrangement in the ordinary heat-exchanger apparatus.

The original article illustrates such a two-stage heat exchanger installed in a New England paper mill. A comparison of the operating records at this plant before and after this system was installed shows considerable savings due to the heat-recovery apparatus. On a certain date the throughput of the mill was 15 per cent more than on the same date of the previous year, but the steam consumption was only 210,000 lb. on that day in 1929 as compared with 315,000 for the same day of 1928. This means that the steam saving for the entire mill resulting from the use of the heat-exchanger system amounted to about 42 per cent.

This same system is now being adapted for use in the connection with pulp digesters where a large saving is expected because of the high temperature of the steam and liquor. (*Power Plant Engineering*, vol. 34, no. 4, Feb. 15, 1930, pp. 213–14, 2 figs., *d*)

A Supercharging Blower for Diesel Engines

TESTS have recently been carried out on a new supercharging and scavenging air blower for a Diesel engine designed in England. The blower is equally suitable for scavenging in the case of a two-cycle engine and for supercharging with four-stroke-cycle machinery. It has four vanes which rotate in the blower casing, but unlike the usual type of vane pump, the vanes of the blower called "Powerplus" are mechanically controlled to follow the casing contour, which is eccentrically arranged with reference to the axis of the shaft. The blower illustrated in the original article is intended for supercharging a 600-b.hp. Diesel engine, and is said to increase its output to between 750 and 800 b.hp.

This particular blower is intended to run at a speed in the neighborhood of 1000 r.p.m. Viewed from the end, it has a width of about 3 ft., the height, including the pedestal, closely approaching 5 ft., while its length is rather more than 3 ft. Apart from the pedestal, or stool, the blower weighs 8 cwt. with an aluminum-alloy casing. The shaft is drilled and forced lubrication is applied to the vane members, while ball and roller bearings are employed elsewhere. The machine should therefore remain practically free from wear.

The author says he has observed the results obtained at varying pressures of discharge, and gives a few of the leading details. At a pressure of 3 lb. per sq. in., with the blower delivering about 2200 cu. ft. per min., the power absorbed was approximately 32 b.hp. (the drive being furnished by an electric motor). At 4 lb. per sq. in. discharge pressure the input was 43 b.hp. As regards the air temperatures, that of the testing shop was 15 deg. cent. The air-discharge temperature at 3 lb. per sq. in. was 32 deg. cent., at 4 lb. per sq. in. 36 deg. cent., and at 5 lb. per sq. in. (the maximum pressure recorded) 42 deg. cent.

Some interesting figures as regards the efficiency of the blower are available from figures which have been recorded by the manufacturers. The designed swept volume per revolution is 78 liters (2.75 cu. ft.) of air. At 960 r.p.m., with a discharge pressure of 5 lb. per sq. in., the free air delivered by the blower is 2100 cu. ft. per min. and the power absorbed 55 b.hp. The compression efficiency (adiabatic) is 79 per cent and the volumetric efficiency 75 per cent. (*The British Motor Ship*, vol. 10, no. 118, Jan., 1930, pp. 424–425, 3 figs., *d*)

Welding for Boilers, Pressure Vessels, and Steam Lines

THE A.S.M.E. Code now permits welding for pressures not over 15 lb. for steam and 160 lb. for water in heating boilers. Welding is also admissible in power-boiler construction for certain details, and a recent revision of the code permits the welding of turned-in flanges and of rings formed of steel plate for fire-door and similar openings as well as of flanged-in edges of water legs.

Of influence in the favorable attitude toward welding of boiler drums is the growing opinion that if such drums could be welded throughout so as to eliminate microscopic cracks and seams likely to exist in riveted joints, the tendency toward concentration of caustic salts therein and consequent embrittlement of the plate would be eliminated. No attempt has as yet been made to experiment with this application of welding under proper working conditions, but it is being considered in a number of plants where plate-cracking troubles have been experienced. If loss of riveted drums from embrittlement should continue as it has during the past few years, experimental installations of all-welded drums for water-tube boilers will quite certainly be heard of.

Massachusetts gives little credit to welded construction, while in Canada a much more liberal attitude toward welding is shown. For unfired pressure vessels the code permits welding on a much larger scale.

Piping for heating and power plants has shown greater advance in fusion welding than boilers or pressure vessels, due, perhaps, to the general absence of legal restrictions as to such construction. Designing and construction forces have been able to use their best judgment as to fabrication of piping, valves, and fittings to secure greatest durability and freedom from trouble.

Large industrial plants that maintain both piping and welding

gangs have found that welders under emergency conditions are able to handle erection or repair work in a safe and dependable manner in a fraction of the time needed for the ordinary threaded or flanged fitting methods. From experimental and emergency attempts, welding has developed to large-scale operations, the forming of tees and ells with eccentric branches, which would be difficult with cast or forged fittings, being effectively done and extremely simple. Branches can be taken from a main at top or bottom to point in any desired direction, giving limitless arrangements of connections, so that the piping installation will be not only more economical but the system will be more efficient, drain more readily, and be free from pockets and air binding.

Welding in piping is used even where the pressures are quite high. A manual of standards for welding piping construction is in preparation. Expansion of the use of the cutting torch now employed to cut large pipes to length so as to join pipes seems a logical step. There is a welded piping code in Michigan, and one is in preparation in Ohio. Ontario and British Columbia, Canada, it is understood, require inspection of piping systems, and welding is provided for, although definite codes have not been established. (C. W. Obert, Union Carbide and Carbon Research Laboratories, L. I. City, N. Y., in a paper before the International Acetylene Association, Chicago, Nov., 1929; abstracted through *Power Plant Engineering*, vol. 34, no. 3, Feb. 1, 1930, pp. 174–175, *p*)

Heat Transfer in Water Pipes

THE author claims that heat flow in water pipes is controlled by the same relations as in the flow of air and steam, which if true would make it possible to find an expression for the law of heat transfer independent of the material involved and its state of aggregation.

In a previously published investigation (*Die Wärme*, Nos. 32 and 33, 1929) the author attempted to prove that the heat transfer from air or steam to a pipe wall is a function of a hydrodynamic magnitude which, in turn, depends on a wall coefficient Δ and increases linearly as the latter decreases. In the present paper the author extends his investigation to the case of water in pipes.

The great difficulty in respect to the determination of the flow of heat between the water and the pipe wall has led to a considerable difference in the results obtained by various investigators in their attempt to determine the laws governing this flow. The reason for this rests mainly in the fact that certain controlling factors, in this case resistance to flow and the differences in the distribution of velocities over the pipe cross-section, as well as difference in wall temperature, have either not been sufficiently closely observed or did not show that presumed simple behavior which was posited as a basis of calculation by various investigators. As a matter of fact, the author believes that the hydrodynamic and thermal magnitudes on the knowledge of which the formulation of the law of heat flow must be based are so closely interconnected that they cannot be calculated exactly with the means now available. This applies particularly to the relations existing in the turbulent initial section of flow and to the effect of the roughness of the pipe wall.

Because of lack of space most of the steps in the author's derivation of his equations, particularly his quotations from others, must be omitted. The author's work is based primarily on the data published by Dr. Soennecken in *Forschungsarbeiten*, Nos. 108 and 109. Unfortunately for this case, however, in Soennecken's papers numerical data are given for only a very small number of experiments. The primary conclusions which the author draws from Soennecken's work and other previous investigations are as follows:

1 The heat transfer increases with increase in wall temperature because the kinematic viscosity in the denominator of the formula expressing heat transfer rapidly increases with increase of wall temperature. Furthermore, the heat conductivity of water increases somewhat with the temperature.

2 The influence of the average water temperature, if at all apparent, is negligibly small and does not appear at all in the equation for heat flow.

3 Corresponding with the decrease in resistance to flow with increase in pipe diameter there is also a similar influence on the flow of heat.

From Soennecken's results it would appear that the amount of heat transfer α_b increases with $(1 + b \times t_w)$, where t_w is the wall temperature and b is equal to 0.018. Furthermore, it would appear that in the case of brass pipe the heat transfer is but very little affected by the average water temperature. There does not seem to be anything to indicate that the water pressure has any effect on the heat transfer. Equations are derived for the value of resistance to the flow of water.

From tests with an iron pipe the following equation was derived.

$$\alpha_b = \frac{\lambda}{\Delta}$$

where λ is the heat conductivity. If $\Delta = 1$, the above equation would become one defining the principle of heat conductivity. If true, it would appear that the flow of heat in pipes takes place in a simple manner, independent of the material and its state. In the form $\alpha_b = C\lambda/\Delta$ it would appear that with the proper coefficient the above simple law applies to water, and undoubtedly to other liquids. For certain cases $C = 1$. (Franz Jaklitsch, Instructor at the Technical High School in Graz, in *Die Wärme*, vol. 52, no. 46, Nov. 16, 1929, pp. 851–854, *tm*)

REFRIGERATION

Tendencies in Modern Refrigeration Design—Outworn Theories

THIS is an abstract of a paper read on January 9 before the British Association of Refrigeration by B. C. Oldham. In the first part the author surveys the development of modern high-speed compressors and deals with valve design. He believes that this is the principal factor limiting speed, and that the sleeve-valve compressor is the only type of refrigerating compressor which can dispense with the suction valve. Subcooling of the liquid refrigerant is useful only for supercharged compressors. Liquid precooling should be used in carbon dioxide plants of any but the smaller sizes. On the other hand, the author condemns as a fallacy the practice followed by some makers in water jacketing their compressors, in an endeavor to reduce the discharge temperature, with its resultant excessive superheating of suction vapor. It is, he said, far preferable to improve the conditions of the gas at the end of the suction stroke.

The formula $1 - \frac{T_d - T_s}{1330}$ which has for many years been used for superheat efficiency in slow-speed vertical single-acting ammonia compressors, is, the author believes, fundamentally at fault.

It may be considered by some, he said, that it is necessary to design the pistons of refrigerating machines on a more liberal basis than in internal-combustion engines, on account of the liability of liquid getting into the cylinder in quantities greater than the clearance space can accommodate, with consequent shock on the piston. In this connection it may be suggested that trouble with liquid flush-over into a compressor cylinder can be very much reduced if more care is taken in the arrangement of suction piping to avoid places in which liquid can accumulate

until choking occurs and the liquid is carried *en masse* to the compressor. These accumulations of liquid are generally the result of small surges over from the evaporator, and the modern trend of evaporator design, with liquid traps from which excess of liquid is returned to the inlet of the evaporator or valves which control the condition of the suction gas, tends toward the elimination of the necessity of designing against the effects of liquid in the compressor cylinder.

The superheat conditions obtained from the Mollier diagrams, and also published in the form of tables by the U. S. Bureau of Standards and the A.S.R.E., give ideals based on pure adiabatic conditions, and the method of computation specified for the American standard ton of refrigeration, while being much more precise than the continental rating, or the rating proposed by the Refrigeration Research Committee of the Institution of Mechanical Engineers, is, in the author's opinion, fundamentally incorrect, and useful only as a basis of comparison, giving only approximate values. The author prefers to use values which represent, as nearly as possible, the actual conditions existing, and for this purpose has overhauled the superheat tables issued by the U. S. Bureau of Standards, and is also reconstructing the Mollier type of diagram to represent these conditions.

TABLE 1 THERMODYNAMIC PROPERTIES OF SUPERHEATED AMMONIA VAPOR

		As per U. S. Bureau of Standards		As per B. C. Oldham	
Temperature, deg. fahr.	Volume, cu. ft. per lb.	Heat content, B.t.u. per lb.	Entropy	Heat content, B.t.u. per lb.	Entropy
Saturation Temperature, 5 Deg. Fahr.; Pressure, 34.27 Lb. per Sq. In. Abs.					
Saturation	8.150	613.3	1.3253	613.3	1.3253
10	8.258	616.3	1.3317	616.1	1.3312
20	8.471	622.2	1.3441	621.4	1.3424
30	8.680	627.9	1.3559	626.6	1.3533
40	8.886	633.6	1.3673	631.8	1.3637
50	9.090	639.1	1.3783	636.9	1.3739
60	9.292	644.6	1.3890	641.9	1.3836
70	9.492	650.1	1.3994	647.0	1.3933
80	9.690	655.5	1.4095	652.0	1.4026
90	9.887	660.9	1.4194	656.9	1.4120
100	10.083	666.2	1.4291	661.8	1.4211
Saturation Temperature, 19.8 Deg. Fahr.; Pressure, 48 Lb. per Sq. In. Abs.					
Saturation	5.934	617.7	1.2973	617.7	1.2973
30	6.096	624.0	1.3103	623.5	1.3093
40	6.251	630.0	1.3225	629.0	1.3205
50	6.404	635.9	1.3341	634.5	1.3313
60	6.554	641.6	1.3453	639.8	1.3415
80	6.848	652.9	1.3666	650.2	1.3613
100	6.993	664.0	1.3868	660.4	1.3800

A specimen of the author's revised tables relating to ammonia, with the Bureau of Standards table as comparison, is shown in Table 1, by which it will be seen that discharge conditions obtained in practice can actually be forecast.

For every ratio of suction and discharge pressures measured inside and not outside the compressor cylinder with the same percentage of clearance, there is a constant factor, varying only with the exponent of the law of the compression and reexpansion curves, depending on the refrigerant or other vapor to be compressed, which, when multiplied by the suction pressure, gives the power consumed for a given piston displacement, either in a practical or in an ideal compressor. The author had devised a method by which these factors can be plotted on a chart to cover any range of ratios and any value of the exponent n of the adiabatic law. An important feature of this type of chart is that it is universal for all refrigerants, or other vapors in any quality of vapor which is found in a correctly operated compressor, and is readily modified or extended to give factors for brake horsepower for any given mechanical efficiency, and also for either indicated or brake horsepower of supercharged compressors for any amount of supercharge. Fig. 11 shows this type of chart applicable to a range of ratios of compression from 1 to 30, for any value n from the pure adiabatic for air, through the whole range of refrigerants, down to the isothermal, and for any ratio of clearance volume to swept volume from 2 per cent to 4 per cent.

A single horizontal measurement gives a factor which, when multiplied by the absolute suction pressure and the piston displacement, gives the total indicated horsepower of a compressor, thus enabling values which normally require an involved set of calculations to be determined in a few seconds, and in the simplest possible manner. Factors for smaller clearances can also be found by a second reading. The effect of extra clearance on power can be gathered from curves *B* and *C*, this effect becoming very marked at wide ratios. There is also a similar falling off in volumetric efficiency, and hence every single-stage compressor has reduced capacity in hot weather when the duty is heaviest.

The author also presents in the original article a chart on which are shown all the pertinent data required in the planning

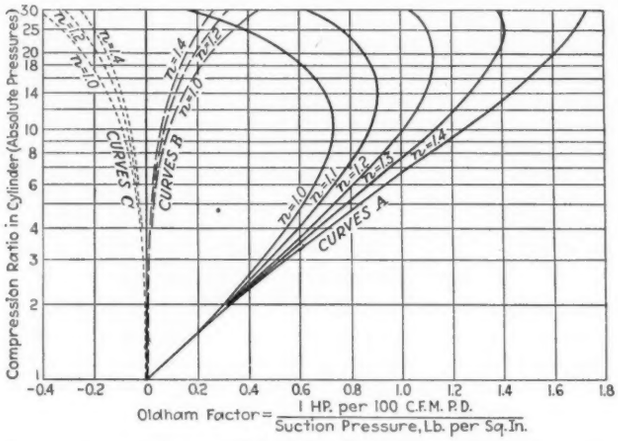


FIG. 11 OLDHAM FACTOR CHART FOR CALCULATION AND COMPARISON OF POWER ABSORBED IN VAPOR COMPRESSION, EITHER SINGLE STAGE, PER STAGE OF COMPOUND COMPRESSION, OR COMPRESSION FROM HIGH-PRESSURE SUCTION IN SUPERCHARGED COMPRESSORS

For 3 per cent clearance read direct from ordinate 0 to curve *A* selected.
For 4 per cent clearance measure from curve *A* selected to corresponding curve *B*.
For 2 per cent clearance measure from curve *A* selected to corresponding curve *C*.
I.hp. per 100 cu. ft. per min. of piston displacement = Oldham factor × suction pressure in lb. per sq. in.
NOTE: This chart gives correct values independent of superheat, and is universal for all vapors which have some superheat at end of compression. It can be readily adapted to show brake horsepower and to give factors for supercharged compressors for given designs.

of multi-tubular and double-pipe condensers and evaporators. This is not reproduced here because of lack of space.

In discussing the matter of condensers the author, among other things, states that experiments which are made from time to time to produce rain by electrical or chemical means, and the formation of water drops in ozonizing apparatus, lead some of us at times to hope that an alternative method of condensing refrigerants may be developed which will render refrigerating plants independent of water in desert countries. Rain making, however, is not an attempt to eliminate heat and actually condense low-pressure steam, but only aims at precipitating minute particles of water already condensed, but so diffused as to be unaffected by gravity.

Evaporator design plays an equally, if not more, important part in the efficiency of refrigerating plants.

The object of all present-day developments in evaporators is to obtain efficient and compact heat-transmitting surfaces, efficient liberating surfaces for the vapor formed, and the reduction of internal friction. When the evaporating refrigerant is subjected to friction in long lengths of piping, the suction pressure in the compressor is necessarily appreciably lower than the mean evaporator pressure, entailing reduced compressor

capacity and a lower coefficient of performance. The vapor formed at the pressure-reducing valve, if not removed near the point of origin, as in multiple-effect compression and in flooded systems, or, alternatively largely prevented by previously subcooling the liquid refrigerant, causes further loss of efficiency in coil-type evaporators by reducing the contact between this liquid and the pipe surface. In some systems operating flooded with a slightly superheated suction, a liquid pump is employed to circulate the refrigerant through the evaporator coils. This the author considers to be a fallacy, as the benefits of the increased heat transmission obtained by more rapid circulation of refrigerant are counteracted by the cost of power to drive the liquid pump. The real advantages of this system are not due to so-called "dry" compression, but to the elevation of the compressor suction pressure, mean evaporator pressure, and the resulting greater weight of gas pumped. This result, however, can generally be attained by the reduction of internal friction by other means. The real field for a liquid pump for liquid refrigerant in compression plants is as a booster in cases where a low-pressure refrigerating medium with high specific gravity of liquid is operated on a high-temperature refrigerating duty. (B. C. Oldham, *Cold Storage*, vol. 33, no. 382, Jan. 16, 1930, pp. 8–11, 3 charts and 1 table, *pA*)

SPECIAL MACHINERY (See also Internal-Combustion Engineering: The Vulcan Coupling for Geared Diesel Engines)

An Italian Three-High Blooming and Slab-Blooming Mill

THIS is a description of a mill installed by the Ernesto Breda Company, of Milan, Italy, and designed to roll slabs of more than two tons each. The application of a three-high mill for such a purpose is somewhat unusual. The top roll is adjustable within very wide limits (1 ft. $3^3/_4$ in. to 1 ft. $5^{11}/_{16}$ in.), and the slab pass in the center of the roll as well as the blooming passes on either side of the slab pass were made very shallow. As the slab pass can, however, also be employed for the first blooming passes in drawing down blooms, it was possible to execute the rolls with a comparatively small diameter, namely, $29^1/_2$ in., with a barrel length of 79 in. An ordinary three-high mill with one fixed and two adjustable rolls (not adjustable during operation) would have required rolls at least $33^7/_{16}$ in. or more in diameter, which would not be suitable for three-high mills. The drive is through a three-phase motor, the speed of which is arranged to brake when a certain torque is reached, thus protecting all those parts of the machinery that are difficult and expensive to replace. The pinions *f* are made of forged steel and their pitch circles have a diameter of 2 ft. $6^1/_8$ in. Each pinion is provided with two separately cut tooth gears, one cutting lagging behind the other by half a tooth pitch. The gearing is designed to insure that several teeth will always be engaged at the same time, thus warranting steady and silent working of the gear.

The distance between the rolls is adjusted by shifting the top and middle rolls, respectively. The middle roll is balanced by weights and raised and lowered by positive gearing with the lifting table. The top roll is adjusted and balanced by an electric drive.

When compared with the hydraulic balancing system of former practice, which method was also perfectly reliable, balancing by weights has the greatest additional advantage of reducing the first cost, because it does away with the auxiliary hydraulic plant, pumps, accumulator, and all accessory details. Hydraulic-pressure plants, moreover, possess many drawbacks inasmuch as their pipe systems and stuffing boxes always show an unpleasant tendency to leak, especially in winter, when the water often freezes even though the utmost care is taken in their manufacture. The electric adjusting and balancing device is totally enclosed, and all the gears are thus protected against dust. All the gears are easily accessible. Finally, the two housing standards are exactly similar, and thus only one spare standard has to be kept in reserve for emergencies.

The worms of both housings are coupled by a divided shaft with a sliding clutch; the motor drives them through a disk coupling (Fig. 12). In adjusting the pressure spindles one of the plates of the disk coupling is used as a brake disk. The 60-b.hp. motor can therefore be controlled by an electromagnetic brake which allows convenient and accurate adjustment. The worm shaft *h* operates two indicating hands, one of which indicates the hundreds, while the other one shows the tens and units, Fig. 13. The correct distance in millimeters either between the middle and top rolls or the middle and bottom rolls can thus be

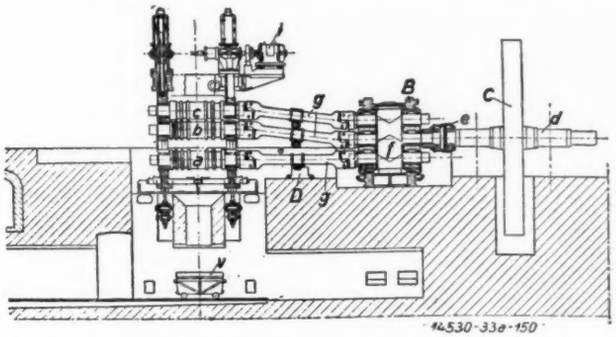


FIG. 12 SECTION OF BREDA THREE-HIGH BLOOMING MILL

immediately ascertained, at any moment, by a glance at the two indicators. Breakers (*c* in Fig. 13) are provided to protect the housings and rolls against breaking. They are of cast iron and designed to break with certainty before any other part of the housing gets overloaded.

The economical working of this three-high blooming mill is chiefly due to the extraordinary simplicity of its driving gear. Reversing blooming mills always require reversible prime movers for driving them because the rotation of the rolls, and consequently of the prime movers, must be reversed after each pass. In order to achieve a high degree of control it is imperative for the reversing gears that the flywheel momentum be as small as possible, but nevertheless the discharge of work from a reversing mill fluctuates far more rapidly and frequently than in continuous working. With the mill herein described the fluctuations of load can be neutralized to a very great extent by means of flywheels. If steam-engine drive is employed, the flywheel is usually mounted on the engine shaft, whereas with electric motors it is placed on a special intermediate shaft. Reversible prime movers are also much more expensive in first cost than continuous mills. If steam engines are used, a reversible twin tandem engine must be substituted for the ordinary uniflow engine. In the case of electric drive, Ilgner transformers are necessary in order to obtain sufficiently rapid acceleration and retarding of the reversible d.c. motors. The Ilgner transformer consists of a control motor working at uniform load and designed for the current available in the supply system. It further comprises one or several control generators supplying direct current of varying tension for the motor driving the rolls. High-speed flywheels on the shafts of these machines serve to neutralize fluctuations in the loads. Instead of a single roll motor working continuously in one direction only, at least two motors and one or several starting generators will thus be needed.

Together with all the necessary accessories, these would evidently work out much dearer in the aggregate than the one motor working continuously in one direction. (*Iron and Steel Industry*, vol. 3, no. 4, Jan., 1930, pp. 107–110, 8 figs., *dA*)

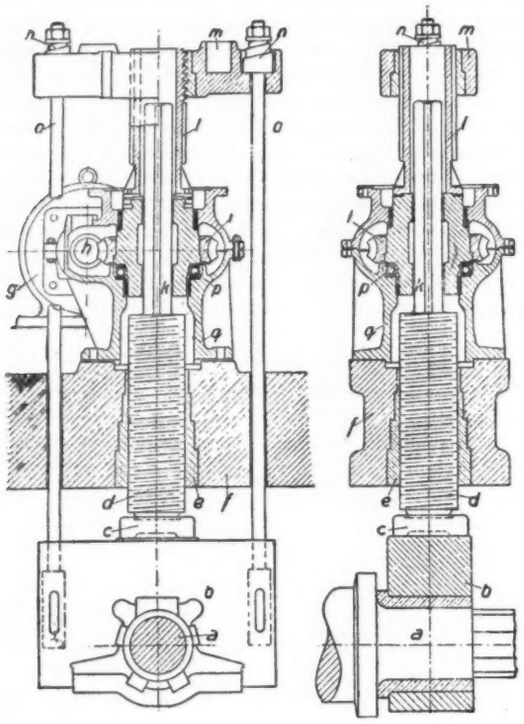


FIG. 13 DIAGRAM OF THE ELECTRIC ADJUSTING AND BALANCING DEVICE OF THE BREDA THREE-HIGH BLOOMING MILL

SPECIAL PROCESSES (See Electrometallurgy: Electrodeposition of Iron)

TESTING AND MEASUREMENTS

Favre's Purely Optical Method for the Photoelasticimetric Determination of Elastic Stresses

H. FAVRE, in charge of installing at the Zurich Polytechnic School a laboratory for optical determination of internal strains, has recently developed a new and purely optical method of photoelasticimetric measurement. He bases his work on two fundamental relations, which he explains as follows:

Consider first a rectilinear ray of polarized monochromatic light arriving normally at a transparent plate of thickness e and in plane equilibrium. Let p and q be the principal strains at point A where the ray strikes the plate. It is known that the incident ray on leaving the plate creates two mixed rays polarized rectilinearly in rectangular planes coincident with the isostatic elements of Lamé at point A. Let us call δ_1 the difference between the incident ray and the emergent ray vibrating parallel to p; and δ_2 the analogous quantity relative to the emergent ray. The author next shows that

$$\delta_1 = (ap + bq)\, e \ldots\ldots [1]$$

$$\delta_2 = (bp + aq)\, e \ldots\ldots [2]$$

where a and b are constants depending on the wave length of the incident ray as well as on the elastic and mechanical properties of the material of the plate. At any point on the same plate lighted by the same monochromatic source of light, δ_1 and δ_2 are functions of only p and q.

$$\delta_1 = f_1(p, q); \quad \delta_2 = f_2(p, q) \ldots\ldots [3]$$

If we assume p and q to be sufficiently small, then by developing the functions f_1 and f_2 into MacLaurin series, the terms containing p and q in powers higher than the square can be neglected, which will give

$$\delta_1 = f_1(0, 0) + \left[\frac{\partial f_1}{\partial p}\, dp + \frac{\partial f_1}{\partial q}\, dq\right]_{p\,=\,0;\ q\,=\,0} \ldots\ldots [4]$$

When the plate is in a state of rest its material is isotropic and monorefringent so that $\delta_1 = \delta_2 = 0$ at all points of the plate; likewise $p = q = 0$, so that $f_1(0, 0) = f_2(0, 0) = 0$. Then

$$\delta_1 = \left[\frac{\partial f_1}{\partial p}\, dp + \frac{\partial f_1}{\partial q}\, dq\right]_{p\,=\,0;\ q\,=\,0}$$

$$\delta_2 = \left[\frac{\partial f_2}{\partial p}\, dp + \frac{\partial f_2}{\partial q}\, dq\right]_{p\,=\,0;\ q\,=\,0}$$

Because of the symmetry which exists between p and q on the one hand and δ_1 and δ_2 on the other, necessarily

$$\frac{\partial f_1}{\partial p} = \frac{\partial f_2}{\partial q}; \quad \frac{\partial f_1}{\partial q} = \frac{\partial f_2}{\partial p}$$

which proves the relations in [1] and [2].

Tests made by the author have shown that in the case of glass it is permissible to neglect in the development of Equation [4] the terms containing p and q as long as p and q are less than 1.30 kg. per sq. mm. (1850 lb. per sq. in.). He has given another and more direct demonstration of his formula.

In accordance with the Brewster principle of superposition, the optical effect produced by two deformations simultaneously effected in a body is the sum of the optical effects which would be produced by each of the deformations if it were the only one present. In other words, the formulas which connect the variation of the indices to the elastic deformations are of linear form. By mathematical reasoning which cannot be reproduced here because of lack of space, the author arrives at formulas of the same type as those given above in [1] and [2].

THE ACTUAL FAVRE METHOD

In order to determine the magnitude of the principal strains p and q at any point of a model, the author uses in addition to Equations [1] and [2] the equation

$$\delta = ce\,(p - q)$$

deduced from the Wertheim law. The coefficients a, b, and c depend, as has been stated before, on the material of the model and the wave length of the light utilized. Their values are determined by preliminary tests on a test piece of the same material illuminated by the same kind of light and subjected to a uniform and known tension.

The article next describes the method used in measuring the differences δ, δ_1, and δ_2. By means of this, at each point of the plate subjected to polarized monochromatic light three equations are obtained for determining the two unknown quantities p and q. There is therefore a superabundance of equations available by which to apply the Gauss theory of errors, which not only makes it possible to calculate the most probable values of p and q in terms of values δ, δ_1, and δ_2 as observed, but also to evaluate the average error in the results obtained.

The advantages of the new method are said to be as follows:

1 It is not necessary to resort to delicate determinations of

lateral contraction, and all the measurements are made at a distance by purely optical means.

2 The measurement of the differences δ_1 and δ_2 is at least as exact as the measurement of lateral elastic deformations. On the other hand, the computation of the principal fatigues makes use of three instead of two observations.

3 The fact that there is one more equation than is necessary makes it possible to apply the classical method of Gauss to calculate the average errors of the results obtained. To give an idea of the degree of precision of this method, Fig. 14 reproduces the results obtained by Favre from a study of a circular disk of Zeiss glass 20 mm. (0.79 in.) in diameter and 4.97 mm. (0.20 in.) thick, compressed by two equal and opposed forces of 21.2 kg. (46.6

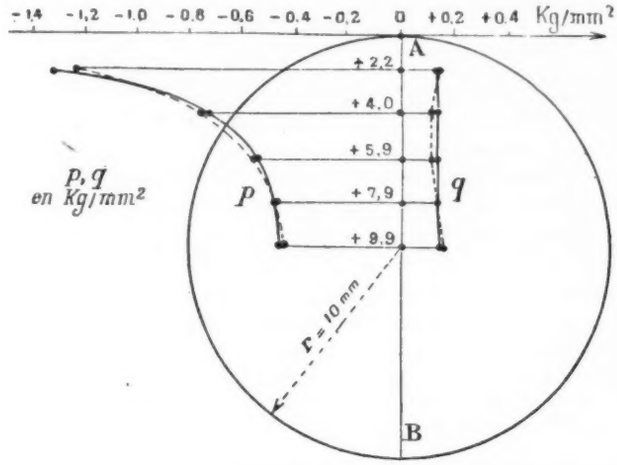


FIG. 14 DIAGRAM OF PRINCIPAL STRAINS p AND q AT FIVE POINTS OF A CIRCULAR GLASS DISK

(Solid-line curves: data obtained by calculation from the theory of elasticity; broken-line curves: data obtained by the application of the Favre optical method.)

lb.) acting on the extremities of the same diameter AB (Fig. 14). The dotted curves show the variation of fatigues p and q along AB as determined by the Favre optical method using the Jamin interferometer. Fatigue p is directed parallel to AB and fatigue q normal to that diameter. As the state of stress in the glass in this case can be determined only by the application of the theory of elasticity, an exact comparison was made with the experimental results. The solid-line curves show the results as obtained by calculation. (*Le Génie Civil*, vol. 95, no. 22, Nov. 30, 1929, pp. 543–545, 1 fig., *teA*)

WELDING (See Power-Plant Engineering: Welding for Boilers, Pressure Vessels, and Steam Lines)

THERMODYNAMICS

Analogy Between Ammonia Refrigerating and Steam Power Cycles

ONLY a brief abstract of this interesting article can be given here. The only real difference between the two cycles is that the pressures in different parts of the systems differ, and that the action of the steam engine is a reversal of that of the refrigeration compressor. Also, the refrigeration system is simpler, since no pumps are necessary to feed the fluid into the ammonia "boiler." Slight reflection will show that the action of the boiler and of the refrigeration coils is identical. In the boiler the water absorbs heat from the gases of combustion, while in the refrigeration coils the ammonia absorbs heat from the brine. In each case the liquid is warmed up while the other medium, that is gases or brine, is cooled. Either one is a boiler when considered from the standpoint of the working medium, or a refrigerator when considered from the standpoint of the medium supplying the heat.

It is common to hear that the refrigeration cycle is just the reverse of the steam cycle when, as a matter of fact, it is not the reverse; the cycle is the same, as can be seen from Fig. 15. The only real difference is that the action of the engine is reversed. The pressures and temperatures vary as shown in the same parts of the similar systems.

With 170 lb. abs. pressure the steam temperature, as taken from the steam tables, would be 368 deg. fahr. The engine would exhaust this steam to the condenser at about 25 in. vacuum. Here it would be picked up and sent to the boiler-feed pump by the hotwell pump, and would probably reach the feed valve at about 185 lb. and flow into the boiler. Assuming 70-deg. water for the condenser, the heat pressure in the refrigeration system might be maintained also at 170 lb. This corresponds to a temperature of about 86 deg., which would give a temperature

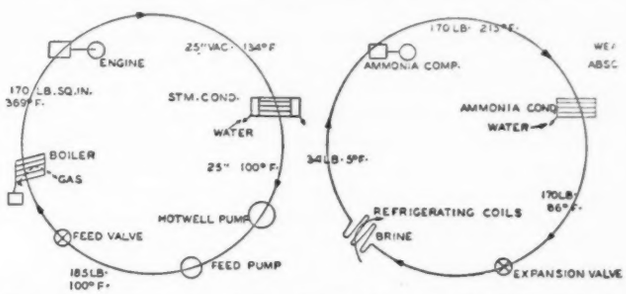


FIG. 15 (*Left*) SIMPLE STEAM-PLANT CYCLE; (*Right*) SIMPLE AMMONIA-COMPRESSION REFRIGERATION-PLANT CYCLE

difference of about 16 deg. between the water and ammonia, which, although not an unusually good value, is a good conservative one. This drop in pressure across the expansion valve depends upon the refrigeration temperature desired and upon the capacity of the compressor in relation to the load. If it is overloaded, the suction pressure will increase. From ammonia tables, which are similar to steam tables, the pressure corresponding to 14 deg. temperature is found to be 42 lb. abs.

In a steam system, if the engine had no governor or throttle valve and the load dropped to, say one-half, the only way to maintain pressures in the system would be to decrease the amount of steam coming from the boiler. In a refrigeration system, if the plant has been operating at constant load and the load is suddenly decreased, the brine will not receive as much heat as the ammonia vapor carries away; therefore the ammonia takes some of the heat from the brine itself and its temperature is gradually lowered. This must be stopped or the brine might freeze. The easiest way to do this is to cut down the amount of ammonia. The compressor is therefore slowed down or the capacity changed by clearance pockets until the amount it handles is just equal to the amount passing through the expansion valve. (P. F. Rogers in *Power Plant Engineering*, vol. 34, no. 3, Feb. 1, 1930, pp. 184–186, 5 figs., *et*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Engineering and Industrial Standardization

The Mechanical Standards Advisory Council[1]

AFTER four years of planning and conferring, the Mechanical Standards Advisory Council desires to take its place with those groups which have been organized to advise their respective industries and the American Standards Association on questions relative to progress in standardization of dimensions, codes, and specifications. The organizers of this Council have striven to enlist the cooperation of every technical society and trade association serving in any way the mechanical industries. This ambition has delayed somewhat the making of a formal statement concerning the organization of the M.S.A.C.

Responding to the call of the A.S.M.E. Standardization Committee, the preliminary conference was held in the Engineering Societies Building on April 7, 1926. This first meeting was attended by representatives of sixteen separate organizations, and the need for an advisory group of this kind was fully and frankly discussed. The desire for systematizing and coordinating the standardization process was expressed by many of the delegates to the conference. Chairman Bliss put it tersely when he stated that the mechanical industry needed to know "What to Standardize," "How to Standardize," and "When to Standardize." This first conference closed with the appointment of a Committee on Policy, Plan, and Scope, with Alfred J. Jupp as chairman. The other members were C. C. Atwood, R. S. Burnett, C. M. Chapman, J. C. Fitts, G. L. Markland, S. L. Nicholson, M. Pirnie, and C. L. Warwick.

The report of this committee was transmitted to the chairman of the first conference in April, 1928. This report recommended the creation of a council for this industry, suggested the name it now bears, and indicated its functions, composition, and form of organization. A second conference was then called for June 20, 1928. Thirteen organized groups were represented. Naturally the principal discussion of this conference centered around the report of the Committee on Policy, Plan, and Scope which was presented by Chairman Jupp. In view of the fact that copies of the report had been broadly distributed sometime prior to the meeting, giving all interested persons and organizations an opportunity to thoroughly examine it, and that no adverse comments had been received, the conference agreed that the report be accepted in principle. Certain points of minor importance which had been raised by the discussion were referred to the Executive Committee for study.

The conference proceeded then to the election of temporary officers and members of the temporary Executive Committee. A. J. Jupp, the representative of the Manufacturers Standardization Society of the Valve and Fittings Industry, was selected as chairman. C. M. Chapman, representing The American Society of Mechanical Engineers, and C. R. Burt, representing the National Machine Tool Builders' Association, were elected first and second vice-chairman, respectively. It was decided that the temporary Executive Committee should number seven, including the three officers.

The constitution of the Mechanical Standards Advisory Council was completed by the temporary Executive Committee in October, 1928, and was broadly distributed. In the following month the Committee called the Council together to effect its permanent organization. This meeting was held in New York on December 3, 1928. Mr. Jupp presided, and representatives of twenty-four organizations having an interest in mechanical standardization attended. After receiving the report of the temporary Executive Committee and discussing the membership of the Council, it voted that the permanent Executive Committee for the first year should consist of the representatives of the following organizations:

American Gas Association
The American Society of Mechanical Engineers
American Society for Testing Materials
Manufacturers Standardization Society of the Valve and Fittings Industry
National Machine Tool Builders' Association
Society of Automotive Engineers.

Accordingly, the present members of the Committee are: A. H. Hall, H. B. Taylor, C. M. Chapman, A. J. Jupp, C. R. Burt, and K. L. Ammerman, named in the order of the organizations which they represent. The committee was also given power to select the seventh member organization. A formal meeting of this Committee was held in New York on December 2, 1929.

A list of the twenty-one member organizations of the Council revised to date is as follows:

American Electric Railway Association
American Gas Association
American Gear Manufacturers Association
American Institute of Steel Construction
American Railway Car Institute
American Society of Mechanical Engineers
American Society for Testing Materials
American Supply and Machinery Manufacturers' Association
American Water Works Association
Association of Manufacturers of Wood-Working Machinery
Bolt, Nut, and Rivet Manufacturers Association
Foundry Equipment Manufacturers Association
Heating and Piping Contractors National Association
Manufacturers Standardization Society of the Valve and Fittings Industry
National Automatic Sprinkler Association
National Electric Light Association
National Electrical Manufacturers Association
National Machine Tool Builders' Association
Power Piping Society
Power Transmission Association
Society of Automotive Engineers.

Eighteen additional organizations have been in close touch with the development of the Council and are formally considering membership.

In making this formal statement to the Standards Council of the American Standards Association, the Chairman of the M.S.A.C., offers the assurance that the Executive Committee is now ready to serve the A.S.A. in every way within its power. For the present, correspondence should be addressed to the Chairman either at his Cincinnati office or care of the A.S.M.E.

(Signed) ALFRED J. JUPP, *Chairman.*

[1] A statement of progress presented to the American Standards Council at its meeting in New York on March 13, 1930.

Federal Specifications and American Standards

ONE of the items of interest on the order of business for the March meeting of the Standards Council of the A.S.A. was a discussion of the Association's cooperation with the Federal Specifications Board. Dr. P. G. Agnew and F. J. Schlink presented the point of view of the A.S.A., while that of the F.S.B. was advanced by Major H. L. Rice, Admiral G. H. Rock, and I. J. Fairchild.

In the early part of the discussion it was pointed out that for the past seven years the A.S.A. has endeavored to assist the F.S.B. in its work of coordinating the Government specifications by distributing copies of tentative drafts to industry for criticism and comment. In some cases the firms addressed through certain societies and trade associations responded fully and satisfactorily, while in others little attention was given to the proposed specification. Some doubt was expressed also as to the extent to which use was made of the criticisms and comments received by the F.S.B. from the A.S.A.

Speaking for the F.S.B., Major Rice assured the Standards Council that the Board desired to continue to consult industry in the development of its specifications. He believed the A.S.A. to be the most convenient and reliable means of establishing that contact. He pointed out, however, that the F.S.B. must be regarded as entirely different from a standardizing body in a national sense. It was set up by presidential order to formulate specifications for materials used by two or more branches of the Government, and solely for their use in procurement. As a consequence the Board did not want industry to tell it what its specifications should be. While he believed that the F.S.B. had accomplished much during the nine years of its existence, he maintained that its specifications were not intended as standards. This accounted in part for the Board's decision that its published specifications should not bear the endorsement of any other body. The members of the Board were glad to see American Standards developed, but believed that their specifications were something different. They were designed to carry out the law, and were necessarily limited specifications for a limited purpose.

Mr. Fairchild stated that he was sure Dr. G. K. Burgess, Chairman of the F.S.B., desired that it should cooperate in every way possible with the A.S.A. in an effort to make federal specifications conform to industrial practice. In fact, he knew of a number of cases where the Board had taken over in their entirety A.S.A. standards, e.g., malleable-iron and cast-iron pipe fittings.

Admiral Rock expressed the belief that in time the present apparent differences of opinion would be harmonized. He stated that while the Navy was not obliged to use federal specifications if they did not meet its needs, it did have to pay attention to costs in its purchasing, and desired that as many as possible of the articles which it purchased should agree in every important particular with those in common use in industry. Further, he said, that if desired he would be glad to see that a material engineer from the Navy was appointed to sit with the special committee that might be appointed to study this subject and prepare recommendations for the Standards Council.

NEW AMERICAN STANDARDS

The following standards were approved by the A.S.A. during the period January 15–April 15, 1930:

Standard Method of Test for Saponification. (American Standard.)

Method of Test for Detection of Free Sulfur and Corrosive Sulfur Compounds in Gasoline. (American Tentative Standard).

Method of Test for Toughness of Rock. (American Standard).

Method of Sampling Stone, Slag, Gravel, Sand, and Stone Block, for Use as Highway Materials. (American Standard.)

Standard Method of Test for Penetration of Bituminous Materials. (American Standard.)

Standard Method of Float Test for Bituminous Materials. (American Standard.)

Method of Test for the Determination of Bitumen. (American Standard.)

Sponsored by the American Society for Testing Materials. Published by the A.S.T.M.

Standard Methods of Routine Analysis of Dry Red Lead. (American Standard.)

Proprietary Sponsor—American Society for Testing Materials. Published by the A.S.T.M.

Safety Code for Prevention of Dust Explosions Covering Pulverized Systems for Sugar and Cocoa. (American Standard.)

Sponsored by the Department of Agriculture and the National Fire Protection Association. Published by the N.F.P.A.

Specifications for Putty. (American Tentative Standard.)

Sponsored by the Bureau of Standards. (Existing Standards Method.) Published by the B. of S.

Specifications for Liquid Soap. (American Tentative Standard.)

(Existing Standards Method.) Published by Bureau of Standards.

Code for Woodworking Plants. (American Standard.) Sponsored by the International Association of Industrial Accident Boards and Commissions, and the National Bureau of Casualty and Surety Underwriters. Published by the Bureau of Labor Statistics.

Use of Explosives in Bituminous Coal Mines. (American Recommended Practice.) Sponsored by the Mine Inspector's Institute.

Standardization of Wrought-Iron and Wrought-Steel Pipe and Tubing

A MEETING of Subcommittee No. 1 of the above-named Sectional Committee was held recently in Detroit. It received a report from the Subgroup on Basic Formulas and decided to urge the pipe-manufacturing and using industries to set up satisfactory S values for the proposed basic formula.

This Subcommittee on Plan and Scope also took actions encouraging Subcommittees Nos. 2 and 3 to proceed with the consideration of the P/S ratings and the scheduling of thickness dimensions for the various diameters of pipe in agreement with such ratings. It is expected that this operation will reduce certain of the present commercial standards for thickness, the outside diameters remaining the same.

The A.S.T.M. and the A.S.M.E. are joint sponsors for this project under the procedure of the A.S.A.

Symbols for Heat and Thermodynamics

Proposed American Tentative Standard

SUBCOMMITTEE No. 3 on Symbols for Heat and Thermodynamics of the Sectional Committee on Scientific and Engineering Symbols and Abbreviations has prepared the following proposed American Tentative Standard Symbols for Heat and Thermodynamics. Dr. Sanford A. Moss is chairman of this Subcommittee. The officers and members of the Executive Committee of the Sectional Committee are J. Franklin Meyer, Chairman, Physicist, Bureau of Standards, Washington, D. C.; Sanford A. Moss, Vice-Chairman, Mechanical Engineer, Thomson Research Laboratory, General Electric Company, West Lynn, Mass.; Preston S. Millar, Secretary, General Manager, Electrical Testing Laboratories, New York, N. Y.; S. McK. Gray, Assistant Secretary, Engineering Assistant to General Manager, Electrical Testing Laboratories, New York, N. Y.; Dr. Arthur E. Kennelly, Professor of Electrical Engineering, Harvard University, Cambridge, Mass.; Dr. Harvey N. Davis, President, Stevens Institute of Technology, Hoboken, N. J.; and Charles M. Spofford, Consulting Engineer, Boston, Mass.

The proposal reproduced below represents a thorough revision and rearrangement of the earlier reports of the Subcommittee on Symbols for Heat and Thermodynamics embodying the results of many criticisms and suggestions elicited by the circulation of the earlier reports, and including the jointly adopted list of Symbols for Heat Transmission. In some cases this proposal includes symbols which are common to reports of other subcommittees. Every effort has been made to secure agreement in all such cases.

As a step in the A.S.M.E. procedure for approval of standards, these symbols are published for the critical review of the membership. Please address all letters to C. B. LePage, Secretary to the A.S.M.E. Standardization Committee, 29 West 39th Street, New York, N. Y.

Symbols for Heat and Thermodynamics

General Principles

1 It is urged that a complete table of units and symbols used by an author be included at a convenient place in each book, chapter, or paper.

2 In most cases the same symbol shall be used, regardless of systems of units. Thus v is specific volume, whether cc. per gram, cc. per mol., cu. ft. per lb., etc.

3 In cases where more than one system of units is used in a discussion, a single symbol may be used, with addition of subscripts, superscripts, or indices to denote units other than the primary one, such as, p, p_i, p', p''.

4 The same symbol should be used for a given concept, regardless of the number of special values which occur, and subscripts or superscripts should be used to designate them.

5 Letter subscripts should be used to denote values under special conditions or in special states. A double-letter subscript without comma denotes a value or change of a value between two conditions or states.

Specific heat at constant pressure	c_p
Specific heat at constant volume	c_v
Thermal efficiency	e_t
Mechanical efficiency	e_m
Heat content of dry saturated vapor	h_g
Change in specific volume during vaporization	v_{fg}

6 Numerical subscripts should be used to denote values at designated points in an apparatus, process, or cycle. A double numerical subscript without comma denotes a value or change of a value between two points, sometimes requiring specification of path.

Initial pressure	p_1
Final pressure	p_2
Weight of a major item	W
Weights of auxiliary items	W_1, W_2, W_3
Heat transferred per pound between points 3 and 4	q_{34}

7 In order to increase the clarity of printed matter, which is practically always roman, symbols alone or in equations should be printed in italics.

8 Where possible, capital letters denote total quantities and small letters denote specific quantities, or quantities per unit. Thus,

S may be entropy of any mass, and
s may be entropy of unit mass.

9 When in a given discussion different concepts from one or more symbols lists have the same symbol without alternatives, this symbol preferably should be used for each concept, with the addition of a subscript selected by the author in all cases or all but one case.

General Symbols

Acceleration due to gravity, for most engineering work, where it is not necessary to distinguish between the exact local value and the standard value given below	g
Acceleration due to gravity. Internationally adopted standard value 980.665 cm./sec.^{2} or 32.1740 ft./sec.^{2}, for precise work where it is necessary to distinguish between this standard value and the local value at any point	g_0
Acceleration due to gravity. Local value at a given point, for precise work where it is necessary to distinguish between this local value and the above-mentioned standard value	g_L
Time	τ (tau) or t (τ (tau) should be used only when t is used for ordinary temperature in the same discussion. See "Temperature.")
Angular velocity (omega)	ω
Velocity[1] (Additional symbols may be found necessary in steam-turbine and allied problems.)	V
Revolutions per unit time	n
Length	L
Diameter	D
Radius	r
Area	A
Total volume[1]	V

Symbols for Force, Weight, Work, and Power

Force; total load	F
Pressure; absolute pressure; gage pressure; force per unit area	p
Mean effective pressure	p_m

[1] See Principle 9.

Total quantity of fluid, water, gas, heat; quantity by volume ..... Q

Volume per unit time; rate at which quantity of material passes through a machine; quantity of heat per unit time; quantity of heat per unit weight ..... q

Total weight[2] ..... W

Weight rate; weight per unit of power; weight per unit of time[2] ..... w

Weight per unit time per unit area of cross-section, commonly called mass velocity ..... G

Mass ..... m

Total work[2] ..... W

Work per unit weight[2] ..... w

Power; work per unit time ..... P

Efficiency ..... e or (eta) η

Symbols for Properties

Molecular weight ..... M

Concentration; amount of particular constituent per given amount of mixture C

Specific volume; volume per unit weight; volume per unit mass v

Density; weight per unit volume; mass per unit volume; specific weight ..... d or (rho) ρ

$$\rho = 1/v$$

Specific heat c

Specific heat at constant pressure ..... c_p

Specific heat at constant volume ..... c_v

Ratio of specific heats ..... κ (kappa) or k

$$k = c_p/c_v$$

Absolute viscosity; coefficient of viscosity, usually in poises or similar units of stress/shear rate ..... (mu) μ

Relative viscosity; ratio of absolute viscosity of any fluid to absolute viscosity of water ..... Z

$$Z = \mu/\mu_w$$

Kinematic viscosity (absolute viscosity divided by density) ..... (nu) ν

Relative kinematic viscosity ..... Use ν/ν_w

Time in seconds obtained from a viscosity measurement with a specific instrument, from which viscosity may be computed by appropriate formulas ..... t

Symbols for General Thermodynamics

Mechanical equivalent of heat ..... J

Heat equivalent of work ..... $1/J$ or A

Ordinary temperature, fahrenheit (F) or centigrade (C) (θ is preferably used only when t is used for time in the same discussion) ..... θ (theta) or t

Absolute temperature, F abs. or K ..... Θ or T
[Θ (capital theta) is preferably used only when θ is used for ordinary temperature]

Gas constant in equation $pv = RT$ ..... R
Two values are in customary use. The first is the universal constant, corresponding to v in the above equation as volume per mol (product of molecular weight and volume per unit weight). The second is the particular value for a given gas, corresponding to v as volume per unit weight. The second value is the first value divided by molecular weight M. If desired, a prime or a subscript may be used to distinguish between the two values.

Quality of steam, pounds of dry steam per pound of mixture x

Exponent of polytropic expansion, pv^n = const ..... n

Joule-Thomson coefficient ..... (mu) μ

$$\mu = (dT/dp)_h$$

Adiabatic factor ..... Y

$$Y = \left(\frac{p_1}{p_2}\right)^{(k-1)/k} - 1$$

Symbols for the Thermodynamic Quantities

Entropy. (The capital should be used for any weight, and the small letter for unit weight) ..... S or s

Internal energy; intrinsic energy. The capital should be used for any weight and the small letter for unit weight ..... U or u

Heat content; total heat; enthalpy. The capital should be used for any weight and the small letter for unit weight ..... H or h

$$h = u + A\,pv$$

Helmholtz free energy; internal potential function ... (psi) ψ

$$\psi = u - Ts$$

Gibbs function; total potential function .... z or (Zeta) ζ

$$z = u + A\,pv - Ts$$

Symbols for Saturation, Vaporization, Etc.

Saturated liquid at saturation pressure and temperature; liquid in contact with vapor ..... *Subscript*—f

Dry saturated vapor; dry saturated gas at saturation pressure and temperature; vapor in contact with liquid ..... *Subscript*—g
(This system, carried to a logical conclusion, requires also subscripts for "liquid in contact with solid," "solid in contact with vapor," and "vapor in contact with solid." However, these subscripts are not assigned at this time. Pairs of subscripts would also denote values for fusion or melting and sublimation.)

Conditions at critical point ..... *Subscript*—c

Vaporization values at constant pressure; differences between values for saturated vapor; and saturated liquid at the same pressure ..... *Subscript*—fg

Heat content of saturated liquid; total heat of saturated liquid; enthalpy of saturated liquid, sometimes called heat of the liquid ..... h_f

Heat content of dry saturated vapor; total heat of dry saturated vapor; enthalpy of dry saturated vapor .... h_g

Various values for saturation; various values for vaporization, according to above rules ..... v_f, v_g, v_{fg}

Saturation pressure; saturation temperature ..... p_f, t_f, and T_f, or p_g, t_g, and T_g

Heat of vaporization at constant pressure ..... L or h_{fg}

Heat of fusion and heat of sublimation may be denoted by subscripts affixed to the symbols L or h.

This proposal includes also symbols for heat transmission, developed jointly with the Committee on Heat Transmission of the National Research Council. The Sectional Committee has already developed Symbols for Hydraulics, Aeronautical and Mathematical Symbols, Letter Symbols for Electrical Quantities, and Navigational and Topographical Symbols, all approved by the A.S.A.

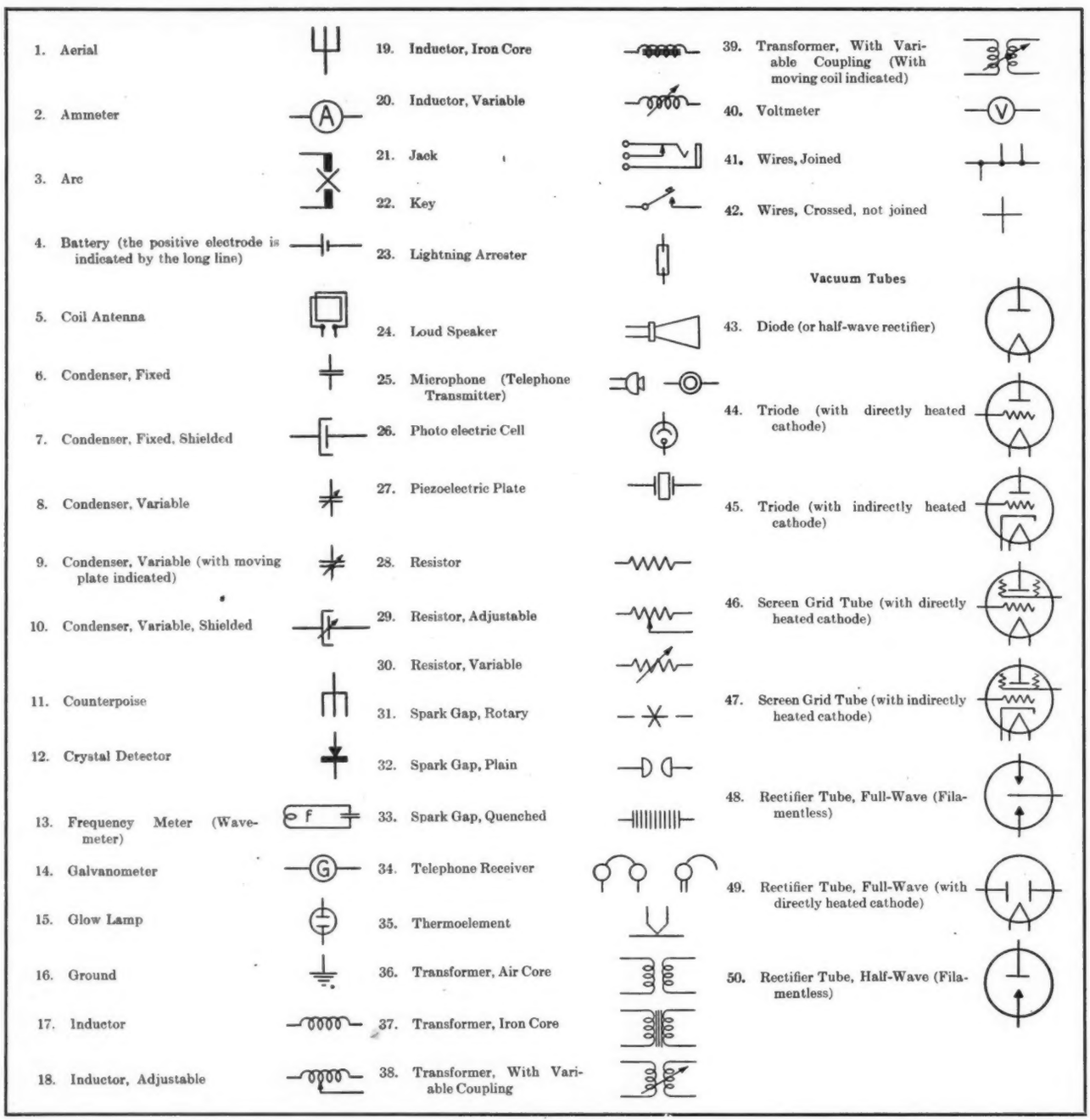
[2] See Principle 9. W_k and w_k are suggested for total work and work per unit weight when necessary.

Graphical Symbols Used in Radio Communication

Proposed American Tentative Standard

THE proposed standard for Graphical Symbols used in Radio Communication was developed by a subgroup of Subcommittee No. 7 on Electrotechnical Symbols including Radio of the Sectional Committee on Standardization of Scientific and Engineering Symbols and Abbreviations. L. E. Whittemore, Engineer, Department of Development and Research, American Telephone and Telegraph Company, New York, N. Y., is chairman of Subgroup No. 3 on Graphical Symbols for Radio, with Dr. J. Franklin Meyer, Physicist, Bureau of Standards, Department of Commerce, Washington, D. C., chairman of Subcommittee No. 7. The officers of the Sectional Committee are the same as those listed on a preceding page in the introductory paragraph of "Symbols for Heat and Thermodynamics." This proposal was developed in close collaboration with the committee on Standardization of the Institute of Radio Engineers.

As a step in the A.S.M.E. procedure for approval of standards, these symbols are published for the critical review of the membership. Please address all letters to C. B. LePage, Secretary to the A.S.M.E. Standardization Committee, 29 West 39th Street, New York, N. Y.



Revisions and Addenda to the Boiler Construction Code

IT IS THE policy of the Boiler Code Committee of The American Society of Mechanical Engineers to receive and consider as promptly as possible any desired revision of the Rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

The Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the Code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticism and comment thereon from any one interested therein. Discussions should be mailed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

After 30 days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

THE FOLLOWING NOTE IS TO BE INSERTED PRECEDING PAR. P-1:

These rules apply to the boiler proper and pipe connections up to and including the valve or valves as required by the Code.

PAR. P-9. REVISE FIRST SECTION TO READ:

P-9. When the maximum allowable working pressure (see Par. P-179) exceeds 160 lb. per sq. in., cross-pipes connecting the steam and water drums of water-tube boilers, headers, cross-boxes and all pressure parts of the boiler proper over 2 in. pipe size, or equivalent cross-sectional area, shall be of wrought steel, or cast steel of Class B grade, as designated in the Specifications for Steel Castings. STEEL CASTINGS FOR PRESSURE PARTS SHALL BE MADE BY THE ELECTRIC-FURNACE OR OPEN-HEARTH PROCESS. When round or square tubing material is used for the construction of sinuous headers of boilers which conforms to the specifications for boiler tubes or other pipe materials as contained in Section II of the Code, the flattening, crushing, or bending tests are not required as the work done on the material forming the sinuous header takes the place of these tests. Malleable iron, as designated in the Specifications for Malleable Castings, may also be used when the maximum allowable working pressure does not exceed 350 lb. per sq. in., provided the form and size of the internal cross-section perpendicular to the longest dimension of the box is such that it will fall within a 7-in. by 7-in. rectangle.

PAR. P-19. REVISED:

P-19. The minimum thicknesses of butt straps for double strap joints shall be as given in Table P-1 IN WHICH THE REQUIRED THICKNESS OF THE SHELL IS THAT OBTAINED BY THE RULES GIVEN IN PAR. P-180 EMPLOYING A VALUE OF E CORRESPONDING TO THE EFFICIENCY OF THE BUTT-STRAP JOINT. Intermediate values shall be determined by interpolation. WHERE THE REQUIRED [For plate] thickness[es] OF THE PLATE EXCEEDS [exceeding] $1^1/_2$ in., the thickness of the butt straps shall be not less than two-thirds of the REQUIRED thickness of the plate. IN NO CASE SHALL EITHER OF THE BUTT STRAPS HAVE A LESSER THICKNESS THAN ONE-HALF THE ACTUAL THICKNESS OF THE PLATE.

CHANGE HEADINGS OF FIRST AND THIRD COLUMNS OF TABLE P-1 TO READ:

"REQUIRED Thickness of Shell Plates, In."

PAR. P-186. REVISED:

P-186. *Welded Joints.* The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 35,000 lb. per sq. in., with steel plates manufactured in accordance with Pars. S-264 to S-279 of Section II of the Code. FUSION [autogenous] welding may be used in boilers, AS HEREINAFTER SPECIFIED PROVIDED THE CARBON CONTENT IN THE STEEL DOES NOT EXCEED 0.30 PER CENT, in cases where the stress or load is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld. Joints between the doorhole flanges of furnace and exterior sheets may be butt or lap-welded by the fusion process, provided these sheets are stayed or otherwise supported around the doorhole opening and provided the distance from the flange to the surrounding row of stays or other supports does not exceed the permissible staybolt pitch as per Par. P-199. If such joints are lap-welded the exterior-sheet flange should preferably be placed on the outside or next to the door opening and the firebox-sheet flange on the interior next to the water. FUSION [autogenous]-welded construction may be used in lieu of riveted joints in the fireboxes of internally fired boilers, provided the welds are between two rows of staybolts, or in the case of flat surfaces the weld is not less than one-half of a staybolt pitch from the corner.

NON-PRESSURE PARTS MAY BE TACK-WELDED TO THE SHELL OR DRUM OF A BOILER, PROVIDED THE STRENGTH OF THE SHELL OR DRUM IS COMPUTED WITH SUCH WELDS CONSIDERED AS THE EQUIVALENT OF HOLES DRILLED THROUGH THE SHELL OF THE FOLLOWING DIAMETERS:

a FOR MATERIAL CONTAINING MORE THAN 0.30 PER CENT CARBON, SUCH AS THAT USED IN FORGED SEAMLESS STEEL DRUMS, THE DIAMETER OF THE EQUIVALENT HOLES SHALL BE TAKEN AS TWICE THE MAXIMUM DIMENSION OF THE WELD, BUT IN NO CASE SHALL A WELD EXCEED 1 IN. IN LENGTH.

b FOR MATERIAL CONTAINING NOT TO EXCEED 0.30 PER CENT CARBON, THE DIAMETER OF THE EQUIVALENT HOLES SHALL BE TAKEN AS THE MAXIMUM DIMENSION OF THE WELD PLUS $^1/_2$ IN., BUT IN NO CASE SHALL A WELD EXCEED 3 IN. IN LENGTH.

c THE EFFICIENCY OF THE LIGAMENTS BETWEEN ANY TWO OF THE WELDS (CONSIDERED ON THE BASIS OF EQUIVALENT HOLES) SHALL NOT BE LESS THAN THE REQUIRED EFFICIENCY FOR LIGAMENTS OR LONGITUDINAL JOINT OF THE DRUM.

WHERE THE DRUM AND THE ATTACHED PARTS ARE HEAT-TREATED OR STRESS-RELIEVED AFTER THE NON-PRESSURE PARTS HAVE BEEN ATTACHED BY FUSION WELDING, NO DEDUCTION NEED BE MADE ON ACCOUNT OF THE WELD.

THE ENDS OF INNER BUTT STRAPS OF RIVETED BUTT-STRAP LONGITUDINAL JOINTS MAY BE FUSION WELDED TO THE EDGES OF HEADS OR TO THE CIRCUMFERENTIAL BUTT STRAPS FOR TIGHTNESS, PROVIDED THE CARBON CONTENT IN THE STEEL DOES NOT EXCEED 0.30 PER CENT.

PAR. P-193. IN THE FIFTH PARAGRAPH OF THE REVISED FORM AS PUBLISHED IN THE OCTOBER, 1929, ISSUE OF "MECHANICAL ENGINEERING," REPLACE "*E*" IN THE FORMULA BY "*K*," AND CHANGE DEFINITION OF "*E*" TO READ AS FOLLOWS:

$K[E]$ = RATIO OF COMPUTED STRESS IN THE SOLID PLATE TO ONE-FIFTH OF THE ULTIMATE TENSILE STRENGTH STAMPED ON THE PLATE, $= \frac{PR}{St}$ [efficiency of longitudinal joint or of ligaments between tube holes (whichever is the least), or the ratio of the stress in the solid plate, circumferentially to *S*.

Make the first four paragraphs section "*a*," the fifth paragraph section "*b*," as shown in the October, 1929, issue, and add the following paragraphs as section "*c*:"

c When tubes are arranged in symmetrical groups along lines parallel to the axis and the same spacing is used for each group, the efficiency for one of the groups shall not be less than the efficiency on which the maximum allowable working pressure is based.

When tubes are unsymmetrically spaced, the average ligament efficiency shall not be less than the following:

a For a length equal to the inside diameter of the drum for the position which gives the minimum efficiency, the efficiency shall not be less than that on which the maximum allowable working pressure is based. When the diameter of the drum exceeds 60 in., the length shall be taken as 60 in. in applying this rule.

b For a length equal to the inside radius of the drum for the position that gives the minimum efficiency, the efficiency shall not be less than 80 per cent of the efficiency on which the maximum allowable working pressure is based. When the radius of the drum exceeds 30 in., the length shall be taken as 30 in. in applying this rule.

c The width of the ligament between any two adjacent holes shall not be less than that given by formula (3) in (*b*) making *d'* in the formula equal the average diameter of the holes at the two sides of the ligament and employing the value of *d* obtained from either formula (1) or (2) in (*b*).

For holes placed longitudinally along a drum but which do not come in a straight line the above rules for calculating efficiency shall hold, except that the equivalent longitudinal width of a diagonal ligament shall be used. To obtain the equivalent width the longitudinal pitch of the two holes having a diagonal ligament shall be multiplied by the efficiency of the diagonal ligament. The efficiency to be used for the diagonal ligaments is given in Fig. P-6$^1/_2$.

PAR. P-195. ADD THE FOLLOWING SECTION:

WHEN THE FLANGE OF AN UNSTAYED DISHED HEAD IS MACHINED TO MAKE A CLOSE AND ACCURATE FIT INTO OR ON TO THE SHELL, THE THICKNESS SHALL NOT BE REDUCED TO LESS THAN 90 PER CENT OF THAT REQUIRED FOR A BLANK HEAD.

PAR. P-197*b*. MODIFY REVISION PUBLISHED IN OCTOBER, 1929, ISSUE TO READ:

b A flanged-IN manhole opening in a dished head shall be flanged to a depth [measured from the outside of the head at the major axis] of not less than 3 times the required thickness of the head, for plate up to 1$^1/_2$ in. in thickness. For plate exceeding 1$^1/_2$ in. in thickness, the depth shall be the thickness of the plate plus 3 in. THE DEPTH OF FLANGE SHALL BE DETERMINED BY PLACING A STRAIGHT EDGE ACROSS THE OUTSIDE OPENING ALONG THE MAJOR AXIS AND MEASURING FROM THE STRAIGHT EDGE TO THE EDGE OF THE FLANGED OPENING. A manhole opening may be reinforced by a riveted manhole frame, or other attachment in place of flanging.

PAR. P-200. REVISED:

P-200. *Staybolts.* The ends of staybolts or stays screwed through plates shall extend beyond the plate not less than two threads when installed, after which they shall be riveted over or upset by an equivalent process without excessive scoring of the sheets; or they shall be fitted with threaded nuts through which the bolt or stay shall extend. The outside ends of solid staybolts 8 in. and less in length, if of uniform diameter throughout their length, shall be drilled with tell-tale holes, at least $^3/_{16}$ in. diameter, to a depth extending at least $^1/_2$ in. beyond the inside of the plate. If such staybolts are reduced in section between their ends below their diameter at the bottom of threads, the tell-tale holes shall extend at least $^1/_2$ in. beyond the point where the reduction in section commences. Hollow staybolts may be used in lieu of solid staybolts with drilled ends. Solid staybolts over 8 in. long, and flexible staybolts of either the jointed or ball-and-socket type, need not be drilled. Staybolts used in water-legs of water-tube boilers shall be hollow, or drilled at both ends, IN ACCORDANCE WITH THE REQUIREMENTS ABOVE STATED, irrespective of their length. All staybolts not normal to the stayed surface shall have not less than three engaging threads, of which at least one shall be a full thread, BUT IF THE THICKNESS OF THE MATERIAL IN THE BOILER IS NOT SUFFICIENT TO GIVE ONE FULL ENGAGING THREAD, THE PLATES SHALL BE SUFFICIENTLY REINFORCED ON THE INSIDE BY A STEEL PLATE RIVETED THERETO.

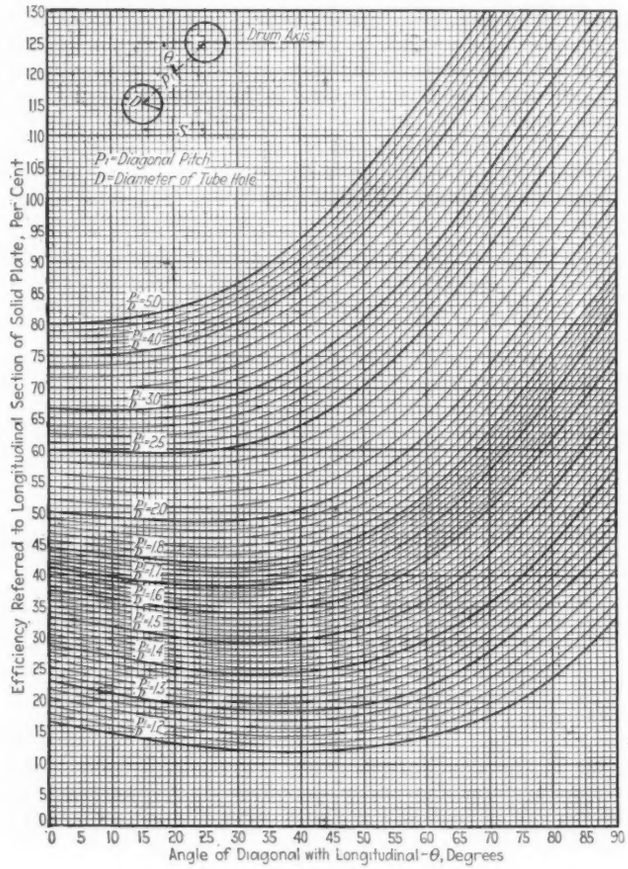


FIG. P-6$^1/_2$

PAR. P-230*a*. REVISE THE DEFINITION OF CHARACTER "*W*" AS FOLLOWS:

W = extreme distance between supports, OR IN A SCOTCH MARINE BOILER, THE DISTANCE FROM THE FIRE SIDE OF THE

TUBE SHEET TO THE FIRE SIDE OF THE BACK CONNECTION PLATE, in.

PAR. P-230*b*. MODIFY REVISION OF LAST PARAGRAPH SHOWN IN OCTOBER, 1929, ISSUE TO READ:

For constructions in which the crown sheet is not semicircular, OR IN WHICH OTHER FEATURES DIFFER FROM THOSE SPECIFIED ABOVE, a test [to destruction] shall be made in accordance with Par. P-247, OR IN SUCH OTHER MANNER AS THE COMMITTEE MAY PRESCRIBE, and the working pressure based thereon.

PAR. P-240. ADD THE FOLLOWING SECTION:

Furnaces Over 38 In. in Diameter. FURNACES OVER 38 IN. IN DIAMETER SHALL BE FULLY STAYED AS FLAT SURFACES IN ACCORDANCE WITH THE REQUIREMENTS OF PAR. P-212*d*.

PAR. P-247. MODIFY REVISION SHOWN IN OCTOBER, 1929, ISSUE TO READ:

P-247. Where no rules are given and it is impossible to calculate with a reasonable degree of accuracy the strength of a boiler structure or any part thereof, a full-sized sample shall be built by the manufacturer and tested in accordance with the standard practice for making a hydrostatic test on a boiler pressure part to determine the maximum allowable working pressure, as given in the Appendix, OR IN SUCH OTHER MANNER AS THE COMMITTEE MAY PRESCRIBE.

PAR. P-251. ADD THE FOLLOWING PARAGRAPH TO THE REVISION SHOWN IN THE OCTOBER, 1929, ISSUE:

TUBES MAY BE SEAL WELDED INTO FITTINGS OR HEADERS, FOR BOTH BOILERS AND SUPERHEATERS, AFTER THEY HAVE BEEN EXPANDED AND FLARED, PROVIDED THE MATERIAL IN THE FITTINGS OR HEADERS DOES NOT CONTAIN CARBON IN EXCESS OF 0.30 PER CENT.

PAR. P-260. INSERT THE FOLLOWING SIDE HEADING: *Reinforcement of Manholes.*

PARS. P-261 AND U-57. REVISED:

P-261. *a* The strength of the rivets in shear on each side of a frame or ring reinforcing manholes shall be at least equal to the tensile strength (required by Par. P-180 using $E = 1$) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole opening.

b THE STRENGTH OF THE RIVETS IN SHEAR IN THE FLANGE OF A NOZZLE RIVETED TO THE DRUM SHALL BE SUFFICIENT, ON EITHER SIDE OF ANY LINE PARALLEL TO THE LONGITUDINAL AXIS, TO EQUAL THE TENSILE STRENGTH OF THE MATERIAL IN THE SHELL MULTIPLIED BY THE AREA GIVEN BY THE FOLLOWING FORMULA:

$$A = T\,(D - d)$$

WHERE A = AREA OF DRUM SHELL ON WHICH STRENGTH SHALL BE COMPUTED, SQ. IN.

T = ACTUAL THICKNESS OF SHELL, IN.

D = MAXIMUM LENGTH, IN., OF SHELL PLATE REMOVED BY THE OPENING PLUS THE RIVET HOLES FOR THE REINFORCEMENT, ON ANY LINE PARALLEL TO THE LONGITUDINAL AXIS OF THE SHELL, THROUGH THE OPENING.

d = LARGEST DIAMETER, IN., OF UNREINFORCED OPENING ALLOWED BY THE RULES IN PAR. P-193.

c THE STRENGTH OF THE RIVETS IN TENSION IN A FLANGE FRAME OR RING RIVETED TO A DRUM, BASED ON THE MINIMUM TENSILE STRENGTH GIVEN IN THE SPECIFICATIONS, SHALL BE AT LEAST EQUAL TO THAT REQUIRED TO RESIST THE STRESS DUE TO THE MAXIMUM ALLOWABLE WORKING PRESSURE WITH A FACTOR OF SAFETY OF FIVE.

THE TENSILE STRESS IN THE RIVETS DUE TO THE STEAM PRESSURE SHALL BE COMPUTED IN THE FOLLOWING WAYS:

(1) FOR OUTSIDE CALKING THE STRESS SHALL BE EQUAL TO THE AREA BOUNDED BY THE OUTSIDE CALKING MULTIPLIED BY THE MAXIMUM ALLOWABLE WORKING PRESSURE.

(2) FOR INSIDE CALKING (AND WITH NO OUTSIDE CALKING) THE STRESS SHALL BE EQUAL TO THE AREA BOUNDED BY THE INSIDE CALKING MULTIPLIED BY THE MAXIMUM ALLOWABLE WORKING PRESSURE.

d IN ORDER TO WITHSTAND THE BENDING MOMENT DUE TO THE PIPING THE RIVETS ATTACHING A NOZZLE TO A DRUM SHALL HAVE A COMBINED AREA NOT LESS THAN 25 PER CENT IN EXCESS OF THE COMBINED AREA CORRESPONDING TO THE OUTSIDE DIAMETER OF THE BOLTS FOR A FLANGED STEEL FITTING OF THE SAME NOMINAL PIPE SIZE, AS GIVEN IN TABLE A-5*b*. THE THICKNESS OF THE FLANGE WHICH IS RIVETED TO THE SHELL SHALL NOT BE LESS THAN 80 PER CENT OF THAT GIVEN IN TABLE A-5*b*, AND THE THICKNESS OF THE BOLTED FLANGE SHALL NOT BE LESS THAN THAT GIVEN IN TABLE A-5. ALSO THE CROSS-SECTIONAL AREA OF THE BASE FLANGE SHALL BE SUFFICIENT TO TRANSMIT THE CIRCUMFERENTIAL TENSION DUE TO SHEAR IN RIVETS WITH A FACTOR OF SAFETY OF FIVE.

e THE RIVETS ATTACHING NOZZLES SHALL BE SO SPACED AS TO AVOID THE POSSIBILITY OF THE SHELL PLATE FAILING BY TEARING AROUND THROUGH THE RIVET HOLES. THIS FEATURE SHALL BE CHECKED BY APPLYING THE RULES GIVEN IN PAR. P-193*c* WHICH BEAR ON THE STRENGTH WHERE A SERIES OF HOLES ARE PLACED IN A DRUM.

PAR. P-265. REVISED:

P-265. A traction, portable, or stationary boiler of the locomotive type shall have not less than six handholes, or washout plugs, located as follows: One in the rear head below the tubes; one in the front head at or about the line of the crown sheet; four in the lower part of the waterleg; also, where possible, one near the throat sheet. IF THE FRONT HEAD IS OBSTRUCTED BY A SMOKEBOX, THE HANDHOLE MAY BE INSERTED IN EITHER SIDE SHEET AT OR ABOUT THE LINE OF THE CROWN SHEET. WHERE PLUGS ARE USED THE REQUIREMENTS IN PAR. P-268 SHALL APPLY.

PARS. P-268 AND U-59. MODIFY REVISION OF FIRST TWO SECTIONS OF *b* SHOWN IN OCTOBER, 1929, ISSUE TO READ:

NOZZLE [*Flanged*] *Fittings, Flared* [*or Expanded*] *Connections.* *b* On shells and spherical portions of the heads, forged steel nozzles such as shown in Fig. P-17 1/2*b* may be inserted through an opening [flared over on the inside to an amount equal to at least the thickness of the neck of the nozzle up to an outside], THE diameter OF which shall not exceed that given for unreinforced circular openings in Par. P-193. THE NECK OF THE NOZZLE IS TO BE HEATED TO A PROPER FORGING TEMPERATURE AND FLARED OVER ON THE INSIDE TO AN AMOUNT EQUAL TO AT LEAST THE THICKNESS OF THE NECK OF THE NOZZLE.

The diameter of the opening shall not be more than 1/8 [1/32] in. greater than the outside diameter of the part of the nozzle which passes through the shell. Such nozzles SHALL [may] be sealed ON THE INSIDE AND INTERMITTENT FILLET WELDED ON THE OUTSIDE by fusion welding provided the carbon content of the steel does not exceed 0.30 per cent and the diameter of the welded seal is at least 1/2 in. less than the maximum diameter allowed by the rules for unreinforced circular openings given in Par. P-193. IF THE ENTIRE STRUCTURE IS STRESS RELIEVED AT A TEMPERATURE OF FROM 950 DEG. FAHR. TO 1050 DEG. FAHR. AFTER ATTACHING A NOZZLE AND SEALING BY WELDING, THE DIAMETER OF THE

HOLE INTO WHICH THE NOZZLE IS FITTED MAY BE MADE THE MAXIMUM DIAMETER ALLOWED BY THE RULES FOR UNREINFORCED CIRCULAR OPENINGS GIVEN IN PAR. P-193.

PARS. P-268 AND U-59. MAKE THIRD SECTION OF *b*, SECTION *c*, AND MODIFY TO READ:

Nozzle Fittings, Expanded Connections. *c* When the thickness of a shell or the spherical portion of a head is [greater than 3/4] 9/16 in. OR ABOVE, forged steel nozzles [the outside diameter of the neck of which does not exceed 4 1/2 in.] may be attached thereto by inserting through an opening and expanding into the shell or head in accordance with the requirements for securing boiler tubes; the diameter of such an opening shall not exceed that given for unreinforced circular openings in Par. P-193. THESE NOZZLES MAY BE SEAL WELDED BY FUSION WELDING PROVIDED THE CARBON CONTENT OF THE STEEL DOES NOT EXCEED 0.30 PER CENT AND THE DIAMETER OF THE WELDED SEAL IS AT LEAST 1/2 IN. LESS THAN THE MAXIMUM DIAMETER ALLOWED BY THE RULES FOR UNREINFORCED CIRCULAR OPENINGS GIVEN IN PAR. P-193.

[All nozzles which are flared over on the inside of the shell or head, except small nozzles where tube-seat grooves are provided, must be forged or machined with a shoulder which rests on a locally flattened surface on the outside of the shell or head to be formed by hot forging, hot flanging, or machining. When the outside of shell or head is machined, the maximum cross-section of the metal removed in a plane passing through the opening and through the center line of the drum shall not exceed that allowed by the rules for unreinforced circular openings given in Par. P-193.]

Change sections *c*, *d*, and *e* to *d*, *e*, and *f*, due to the insertion of new section *c* as above.

PARS. P-268*d* AND U-59*d*. REVISE SIDE HEADING TO READ AS FOLLOWS:

NOZZLE [Flanged] Fittings, Riveted Connections.

PARS. P-268*e* AND U-59*e*. MODIFY LAST SECTION TO READ:

PAR. P-268*e*. MODIFY THE REVISED FORM OF THE FIRST SENTENCE OF THIS PARAGRAPH TO READ AS FOLLOWS:

Nozzle [*Flanged Fittings, Forge-Welded.* *e* Nozzles may be forge-welded, with or without reinforcement, to the shell or to the spherical portions of the head. IF THE ENTIRE VESSEL IS NOT STRESS RELIEVED, THE FORGE-WELDED NOZZLES SHALL BE LOCALLY STRESS RELIEVED BY HEATING UNIFORMLY A CIRCUMFERENTIAL BAND EXTENDING AT LEAST 8 IN. BEYOND THE WELD ON EACH SIDE, THE TEMPERATURE INCREASED SLOWLY TO AT LEAST 1100 DEG. FAHR., HOLDING AT THAT TEMPERATURE FOR A TIME AT LEAST PROPORTIONAL TO ONE HOUR PER INCH OF SHELL THICKNESS, AND ALLOWING TO COOL SLOWLY IN A STILL AIR.

The thickness of the reinforcing pad shall not be less than 3/4 in. when the thickness of shell or head to which the same is fitted is 2 in. or less; when thickness of shell or head is greater than 2 in., the minimum thickness of the pad shall be 1 in. The OUTSIDE DIAMETER [width] of the pad [along the longitudinal axis of the shell] shall not be less than TWICE the inside DIAMETER [radius] of the nozzle [opening].

PAR. P-288. REVISED:

P-288. Every superheater shall have one or more safety valves near the outlet. The discharge capacity of the safety valve or valves on an attached superheater may be included in determining the number and size of the safety valves for the boiler, provided there are no intervening valves between the superheater safety valve and the boiler, and provided the discharge capacity of the safety valve or valves on the boiler, as distinct from the superheater, is at least 75 per cent of the aggregate valve capacity required. A SOOT-BLOWER CONNECTION MAY BE ATTACHED TO THE SAME OUTLET FROM THE SUPERHEATER AS USED FOR THE SAFETY-VALVE CONNECTION.

PAR. P-294. REVISED:

P-294. Each boiler shall have three or more gage cocks, located within the range of the visible length of the water glass, except when such boiler has two water glasses with independent connections to the boiler and located on the same horizontal line and not less than 2 ft. apart.

Locomotive-type boilers not over 36 in. in diameter, OR ANY FIREBOX OR WATERLEG BOILER IN WHICH THE HEATING SURFACE DOES NOT EXCEED 50 SQ. FT., need have but two gage cocks.

PAR. P-301. REVISED:

P-301. *Stop Valves.* Each steam-discharge outlet, except safety-valve and superheater connections, shall be fitted with a stop valve located AT AN ACCESSIBLE POINT IN THE STEAM DELIVERY LINE AND as near TO the boiler NOZZLE as CONVENIENT AND practicable. When such outlets are over 2-in. pipe size, the valve or valves used on the connection shall be of the outside-screw-and-yoke rising-spindle type, and the wheel may be carried either on the yoke or attached to the spindle.

PAR. P-307. REVISED:

P-307. *Blow-off Piping.* A surface blow-off shall not exceed 2 1/2 [1 1/2] in. pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing similar to or equivalent of those shown in Fig. P-18 or a flanged connection, shall be used.

PAR. P-311*a*. REVISE FIRST SENTENCE TO READ:

P-311. *a* On all boilers except those used for traction and/OR portable purposes, when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have two slow-opening valves, or one slow-opening valve and a cock, and such valves, or valve and cock, shall be at least extra heavy construction.

PAR. P-321. REVISED:

P-321. The water connections to the water column of a boiler, when practicable, shall be provided with a cross at each right-angle turn to facilitate cleaning. [For steam pressures of 250 lb. or less, the water connection, if pipe is used, shall be of brass.] The water column shall be fitted with a drain cock or drain valve with a suitable connection to the ashpit, or other safe point of waste, and if the water connection thereto has a rising bend or pocket, which cannot be drained by means of the water-column drain, an additional drain shall be placed on this connection in order that it may be blown off to clear any sediment from the pipe. The water-column blow-off pipe shall be at least 3/4-in. pipe size. For steam pressures over 250 lb., the connections shall be of steel pipe or tubing, wrought-iron pipe or of other material capable of safely withstanding the temperatures corresponding to the maximum allowable working pressure.

PAR. P-324. REVISED:

P-324. A horizontal-return tubular boiler, 14 ft. or more in length, or over 54 in. and up to and including 72 in. in diameter, shall be supported by the outside-suspension type of setting, as specified in Par. P-323, or at four points by not less than eight steel or cast-iron lugs set in pairs. A horizontal-return tubular boiler up to and including 54 in. in diameter shall be supported by the outside-suspension type of setting as specified in Par. P-323, or by not less than two steel or cast-iron lugs on each side.

The distance girthwise of the boiler from the centers of the bottom rivets to the centers of the top rivets attaching the hangers shall be not less than the square of the shell diameter divided by 675. If more than four lugs are used they shall be set in four pairs, the lugs of each pair to be spaced not over 2 in. apart and the load to be equalized between them (see Fig. P-20). IF THE BOILER IS SUPPORTED ON STRUCTURAL STEELWORK, THE STEEL SUPPORTING MEMBERS MUST BE SO LOCATED OR INSULATED THAT HEAT FROM THE FURNACE CANNOT IMPAIR THEIR STRENGTH.

PAR. P-327. REVISED:

P-327. *Access and Firing Doors.* The minimum size of an access door to be placed in a boiler setting shall be 12 by 16 in., or equivalent area, 11 in. to be the least dimension in any case. THE MINIMUM SIZE OF FIREDOOR OPENING IN AN INTERNALLY FIRED BOILER IN WHICH THE MINIMUM FURNACE DIMENSION IS 24 IN. OR OVER, SHALL BE NOT LESS THAN 12 IN. HIGH BY 16 IN. WIDE.

PAR. S-66. REVISED:

S-66. *Transverse Tests.* *a* The transverse-test specimens (arbitration test bars) specified in Par. S-68*a*, when placed horizontally upon supports 18 [12] in. apart and tested under a centrally applied load, shall conform to the following minimum requirements, interpreted in accordance with Par. S-70:

	Class of Casting					
	Light		Medium		Heavy	
Load at center, lb.....	1500	[2500]	1750	[2900]	2000	[3300]
Deflection at center, in...	0.20	[0.10]	0.20	[0.10]	0.20	[0.10]

b The rate of application of the load shall be such that a central deflection of 0.10 in. is produced in from 20 to 40 seconds.

PAR. S-68. REVISED:

S-68. *Test Specimens: Arbitration Test Bar.* *a* The [form and dimensions of the mold for the] arbitration test bar shall be in accordance with THE STANDARD SPECIFICATIONS FOR THE ARBITRATION TEST BAR AND TENSION-TEST SPECIMEN FOR CAST IRON (A.S.T.M. DESIGNATION A 124) OF THE AMERICAN SOCIETY FOR TESTING MATERIALS [Fig. S-5. The bottom of the bar shall be $^1/_{16}$ in. smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask shall be rammed up with green molding sand, a little damper than usual, well-mixed and put through a No. 8 sieve, with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried, and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.]

Tension-Test Specimen. *b* When tension tests are specified, the tension-test specimen shall CONFORM TO THE REQUIREMENTS SPECIFIED IN THE STANDARD SPECIFICATIONS A 124 [be turned from any of the broken pieces of the transverse test specimens, and shall conform to the dimensions shown in Fig. S-6.

A.S.T.M. SPECIFICATIONS A 124 TO BE INCORPORATED IN THIS SECTION.

PAR. S-215. REVISED:

S-215. *Process.* The steel shall be made by THE electric-furnace, open-hearth [one or more of the following] OR OTHER process [es] APPROVED BY THE PURCHASER [converter, or crucible].

PAR. S-217. REVISED:

S-217. *Chemical Composition.* [*a*] The castings shall conform to the following requirements as to chemical composition [except that the following limitations for carbon, manganese, and silicon are intended to show desired composition and are not to be used for rejection:

Carbon.....	0.15–0.45 [0.40] per cent
Manganese.....	not under 0.50 per cent
Silicon.....	not under 0.20 per cent
Phosphorus.....	not over 0.05 per cent
Sulphur.....	not over 0.06 [0.05] per cent

[*b* Manufacturers submitting proposals to furnish material under these specifications shall specify, with their proposals, the limits of carbon, manganese, and silicon which they will accept as a basis for rejection.]

PAR. H-21. REVISE FIRST SECTION TO READ:

H-21. The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p^2}$$

where P = maximum calculated allowable working pressure, lb. per sq. in. (not less than 30 lb.)

T = thickness of plate in sixteenths of an inch

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical, or inclined, in.

C = 112 for stays screwed through plates not over $^7/_{16}$ in. thick with ends riveted over or for stays welded into such plates

C = 120 for stays screwed through plates over $^7/_{16}$ in. thick with ends riveted over or for stays welded into such plates

C = 135 for stays screwed through plates and fitted with single nuts outside of plate, or for stays FITTED WITH WASHERS OF TWICE THE DIAMETER OF THE STAY AND OF THE THICKNESS OF THE PLATES THROUGH WHICH THE STAYS PROJECT AND TO WHICH THEY ARE FUSION welded [into such plates], provided they are supported at intervals not exceeding 6 ft.

[C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate]

[C = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of the washers is not less than 0.4 p and thickness not less than T.]

PARS. H-51 AND H-104. REVISED:

Each safety valve or water-relief valve shall be plainly marked by the manufacturer in such a way that the markings will not be obliterated in service, by stamping or casting on the casing or body of the valve, or by stamping or casting on a plate securely fastened to the casing, the letters A.S.M.E. Std., the manufacturer's name or trademark, and the pressure at which it is set to blow. ALL SAFETY AND WATER-RELIEF VALVES SHALL BE ARRANGED SO THAT THEY CANNOT BE RESET TO RELIEVE AT A HIGHER PRESSURE THAN THE MAXIMUM ALLOWABLE WORKING PRESSURE OF THE BOILER. The seats and disks of safety or water-relief valves shall be made of non-ferrous material.

PARS. H-55 AND H-108. ADD FOLLOWING SENTENCE:

ON A COMPOUND GAGE, THE STOP PINS OR LIMIT STOPS SHALL BE SET AT THE LIMITS OF THE GAGE READINGS ON BOTH THE PRESSURE AND VACUUM SIDES.

PAR. H-68. ADD FOLLOWING SECTION:

WHEN A JACKET OR OTHER FORM OF CASING IS APPLIED TO A

BOILER, AN OPENING WITH REMOVABLE COVER MAY BE PROVIDED FOR VIEWING THE REQUIRED STAMPING, OR THE REQUIRED STAMPING MAY BE DUPLICATED ON THE FRONT PORTION OF THE CASING EITHER ON A NON-FERROUS PLATE, NOT LESS THAN 3 IN. BY 4 IN. IN SIZE, IRREMOVABLY ATTACHED TO THE CASING, OR STAMPED DIRECTLY THEREON.

PAR. H-73. OMIT TABLE H-8 AND REVISE THIS PARAGRAPH TO READ:

H-73. *Filling Material.* The term filling material shall mean the weld rod, filling rod, electrode, or other metal which is used to join two sections of the base metal or metals. [Either of the filling metals given in Table H-8 shall be used for oxyacetylene or electric arc welding, respectively.] WELDING WIRE, RODS, AND/OR ELECTRODES MUST BE SMOOTH AND FREE FROM SCALE, RUST, OIL, OR GREASE. IN THE HANDS OF AN EXPERIENCED WELDER, THE FILLER MATERIAL SHOULD DEMONSTRATE GOOD WELDABILITY AND SHOULD FLOW SMOOTHLY AND EVENLY WITHOUT ANY UNUSUAL CHARACTERISTICS.

The filling metal must be clean, flow freely, and shall neither "spit nor spark" appreciably during welding. Its fusing temperature shall be such as to correspond relatively with that of the sheet, or base metal. The size of the wire and the size of the tip shall be such as to enable the welder to meet the conditions required by the work he is doing with oxyacetylene welding, and the size of the electrode and current characteristics should meet the same conditions for electric arc welding.

PAR. H-83. REVISED:

H-83. Where staybolts are to be welded into stayed plates by the autogenous process the staybolt holes shall be countersunk BY MACHINING OR PRESSING to within at least $^1/_{16}$ in. of the full thickness of the plate. The base metal of the plate and staybolt shall be welded to the full thickness of the plate. The staybolts shall be of such length that they will project at least $^1/_8$ in. above the surface of the plate in which they are welded. No form of stay may be attached by welding unless the method of attachment conforms to the requirements for welding in staybolts. WHERE OUTSIDE WASHERS ARE USED, THE COUNTERSINKING SHALL BE DONE IN THE WASHER AND NOT IN THE PLATE, AND THE WASHERS SHALL BE WELDED TO THE PLATE.

PAR. U-23. MODIFY REVISED FORM OF THIS PARAGRAPH AS IT APPEARED IN JANUARY ISSUE TO READ:

U-23. Pressure vessels MAY [shall not] be fabricated by means of fusion welding under the rules given in Pars. U-67 to U-79, PROVIDED THE FABRICATION IS IN ACCORDANCE WITH THE PROCEDURE FOR FUSION WELDING OF PRESSURE VESSELS GIVEN IN THE APPENDIX, AS FOLLOWS [except]:

a Air vessels, when the inside diameter does not exceed 60 [20] in., OR [the length does not exceed 3 times the diameter, and] the working pressure does not exceed 200 [100] lb. per sq. in., OR THE TEMPERATURE DOES NOT EXCEED 250 DEG. FAHR.

b [Other] Vessels [under these rules], in which the circumferential joints only may be welded, when the inside diameter does not exceed 48 in., or 72 in., when at least 75 per cent of the load on a flat head is supported by tubes or through stays extending from head to head.

c VESSELS OF ALL KINDS AND OF ANY DIMENSIONS, IN WHICH ALL JOINTS MAY BE WELDED, PROVIDED THAT IN ADDITION THE RULES GIVEN UNDER THE "SPECIFICATIONS FOR FUSION WELDING OF DRUMS OR SHELLS OF POWER BOILERS" ARE FOLLOWED (these Specifications were published in the March, 1930, issue of MECHANICAL ENGINEERING, page 235). [Where the vessels are fabricated in accordance with the recommended procedure for fusion welding of pressure vessels given in the appendix, the limiting diameter in par. U-23*a* may be taken as 60 in. and the limiting pressure may be taken at 200 lb. per sq. in., provided the temperature does not exceed 250 deg. fahr.]

PAR. U-51. REVISED:

U-51. Where no rules are given and it is impossible to calculate with a reasonable degree of accuracy the strength of a pressure vessel or any part thereof, a full-sized sample shall be built by the manufacturer and tested in ACCORDANCE WITH THE STANDARD PRACTICE FOR MAKING A HYDROSTATIC TEST ON A PRESSURE PART TO DETERMINE THE MAXIMUM ALLOWABLE WORKING PRESSURE, AS GIVEN IN THE APPENDIX, OR IN SUCH OTHER MANNER AS THE COMMITTEE MAY PRESCRIBE [a manner to be prescribed by the Boiler Code Committee and in the presence of one or more representatives appointed to witness such test.]

PAR. U-59*a*. IN THE FIRST PARAGRAPH, MODIFY THIRD SENTENCE OF REVISED FORM SHOWN IN OCTOBER, 1929, ISSUE TO READ:

If the thickness of the material in the pressure vessel is not sufficient to give such number of threads, the opening shall be reinforced by a pressed-steel, cast-steel, or bronze-composition flange or plate, brazed, FUSION WELDED or riveted on, or a boss may be built up by FUSION [autogenous] welding [process] for an opening not to exceed $1^1/_2$ [2] in. pipe size, [and for a pressure not to exceed 100 lb. per sq. in.] SO AS to provide at least the required number of threads.

IN THE THIRD PARAGRAPH OF THE REVISED FORM OF THIS PARAGRAPH, REPLACE "*E*" IN THE FORMULA BY "*K*," AND MODIFY DEFINITION OF "*E*" TO READ AS FOLLOWS:

K [E] = RATIO OF COMPUTED STRESS IN THE SOLID PLATE TO ONE-FIFTH OF THE ULTIMATE TENSILE STRENGTH STAMPED ON THE PLATE, $= \frac{PR}{St}$ [efficiency of longitudinal joint or of ligaments between tube holes (whichever is the least), or the ratio of the stress in the solid plate, circumferentially to S.]

MODIFY FOURTH PARAGRAPH OF THE REVISED FORM OF THIS SECTION TO READ:

When the maximum allowable working pressure exceeds 100 lb. per sq. in., and the shell thickness is less than $^3/_4$ in., openings over 3-in. pipe size shall not have screwed joints, but flanged fittings shall be used, WHICH ARE expanded, forge-welded, FUSION-WELDED or riveted directly to the shell or head, or a fitting with a raised flat face on the pressure vessel side of the fitting may be connected directly to the SHELL [pressure vessel] or head of the vessel by means of studs, all as hereinafter specified.

PAR. U-59*e*. MODIFY THE REVISED FORM OF THIS PARAGRAPH TO READ AS FOLLOWS:

Nozzle [Flanged] *Fittings, Forge-Welded.* *e* Nozzles may be forge-welded, with or without reinforcement, to the shell or to the spherical portions of the heads, as permitted in Par. U-88. IF THE ENTIRE VESSEL IS NOT STRESS RELIEVED, THE FORGE WELDED NOZZLES SHALL BE LOCALLY STRESS RELIEVED BY HEATING UNIFORMLY A CIRCUMFERENTIAL BAND EXTENDING AT LEAST 8 IN. BEYOND THE WELD ON EACH SIDE, THE TEMPERATURE INCREASED SLOWLY TO AT LEAST 1100 DEG. FAHR., HOLDING AT THAT TEMPERATURE FOR A TIME AT LEAST PROPORTIONAL TO ONE HOUR PER INCH OF SHELL THICKNESS, AND ALLOWING TO COOL SLOWLY IN A STILL AIR.

PAR. U-59*f*. Change the letter of this section to "*g*" and insert new section "*f*" to read as follows:

Nozzle Fittings, Fusion Welded. *f* NOZZLES MAY BE FUSION WELDED, WITH OR WITHOUT REINFORCEMENT, TO THE SHELL OR TO THE SPHERICAL PORTIONS OF THE HEADS AS PERMITTED IN PAR. U-77, PROVIDED THE FABRICATION IS IN ACCORDANCE WITH THE PROCEDURE FOR FUSION WELDING OF PRESSURE VESSELS GIVEN IN THE APPENDIX. SUCH FITTINGS SHALL BE HEATED FOR STRESS

RELIEF IN ACCORDANCE WITH THE REQUIREMENT OF PAR. U-72 AND AS SPECIFIED IN FIG. U-3.

PAR. U-59*g* AND P-268*f*. REVISE SIDE HEADING TO READ AS FOLLOWS:

NOZZLE [Flanged] Fittings, Stud-Bolted Connections.

PAR. U-65. MODIFY REVISION SHOWN IN THE OCTOBER, 1929, ISSUE OF "MECHANICAL ENGINEERING" TO READ:

U-65. Every pressure vessel shall be inspected at least TWICE [once] by a state or municipal inspector of boilers, or an inspector employed regularly by an insurance company which is authorized to do a boiler-insurance business in the state in which the vessel is built, or in the state in which it is to be used, if known [which inspections shall be made one before reaming rivet holes or finally closing the vessel to inspection, and the other when the hydrostatic pressure test is on.] IN THE CASE OF A RIVETED VESSEL, ONE INSPECTION SHALL BE MADE AT THE TIME OF REAMING RIVET HOLES. IN THE CASE OF A VESSEL FABRICATED IN WHOLE OR IN PART BY A WELDING PROCESS, ONE INTERNAL INSPECTION SHALL BE MADE BEFORE FINAL CLOSURE. A FINAL INSPECTION SHALL BE MADE AT THE TIME OF THE HYDROSTATIC TEST. A data sheet shall be filled out and signed by the manufacturer and the inspector, which data sheet, together with the stamping on the vessel, will denote that it is constructed in accordance with these Rules. [Every pressure vessel fabricated in whole or in part by a welding process, shall, when the size of the shell permits, be internally inspected before being finally closed to inspection.]

PAR. U-67. REVISED:

U-67. *Processes.* The fusion process, so-called, shall consist of welding by means of either the oxyacetylene process or ANY [the] electric-arc process, using welding wire, either bare, coated, or covered, OR MELTING DOWN THE BASE METAL.

PAR. U-68. MODIFY REVISED FORM OF THIS PARAGRAPH SHOWN IN JANUARY ISSUE TO READ AS FOLLOWS:

U-68. When welded in accordance with the Procedure for Fusion Welding of Pressure Vessels given in the Appendix, the strengths of joints may be calculated on a maximum unit working stress (*S*), at right angles to the direction of the joint, as follows:
[For] Butt double-V [longitudinal] welds FOR ALL JOINTS 8000 lb.
[For] Butt single-V FOR girth or head welds.....6500 lb.
[For] Double full-fillet lap [or girth] welds, FOR GIRTH JOINTS ONLY.....7000 lb.
[For spot or intermittent girth or head welds.....5600 lb.]

[Unless the Procedure for Fusion Welding of Pressure Vessels given in the Appendix is followed in all particulars, the unit working stress (*S*) at right angles to the direction of the weld shall not exceed 5600 lb. per sq. in. (see Par. U-20).]

PAR. U-70. REVISE FIRST SENTENCE TO READ AS FOLLOWS:

The base metal of shells shall not exceed $^5/_8$ in. thickness, EXCEPT AS PROVIDED IN PAR. U-23*c*.

PAR. U-71. REVISED:

U-71. *Method of Welding.* Longitudinal seams shall be of the double-V type, that is, welded from each side [halfway through the sheet]. Girth and head seams may be of the single-V type, that is, welded entirely through from the outside. Double-V welds shall be reinforced at the MIDDLE [center] of the weld on each side [of the plate] by at least $^1/_{16}$ IN. UP TO AND INCLUDING $^5/_8$ IN. PLATE [25 per cent of the plate thickness.] Single-V welds shall extend entirely through the plate and shall be reinforced at the MIDDLE [center] of the weld by AT LEAST $^1/_8$ IN. UP TO AND INCLUDING $^5/_8$ IN. PLATE [not over 20 per cent of plate thickness]. All welds shall be of sound metal, thoroughly fused to the sides of the V for its entire depth. Sheets must not be allowed to lap during welding. In material $^1/_4$ in. THICK OR LESS THE SINGLE-V TYPE OF JOINT MAY BE USED FOR LONGITUDINAL SEAMS, AND THE BEVELING OF THE EDGES FOR EITHER LONGITUDINAL OR CIRCUMFERENTIAL SEAMS MAY BE OMITTED IF A BACKING-UP STRIP IS USED TO INSURE COMPLETE PENETRATION OR IF THE JOINT IS WELDED FROM BOTH SIDES [or less in thickness, the longitudinal seams need not be beveled. In material less than $^1/_4$ in. thick, beveling the heads will be sufficient, and the shell need not be beveled at the head seams. One side of each girth seam shall be beveled].

There shall be no valley either at the edge or in the MIDDLE [center] of the joint, and the weld shall be so built up that the welded metal will present a gradual increase in thickness from the surface of the sheet to the MIDDLE [center] of the weld.

At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one-quarter of the minimum thickness of the sheets, or plates.

PAR. U-72. RENUMBER THIS PARAGRAPH AS U-73, AND INSERT NEW PAR. U-72 TO READ AS FOLLOWS:

U-72. THE PART OR PARTS OF THE VESSEL SPECIFIED FOR STRESS RELIEVING SHALL BE HEATED UNIFORMLY AND THE TEMPERATURE INCREASED SLOWLY TO AT LEAST 1100 DEG. FAHR. AND HELD AT THAT TEMPERATURE FOR A TIME AT LEAST PROPORTIONAL TO ONE HOUR PER INCH OF THICKNESS, AND SHALL THEN BE ALLOWED TO COOL SLOWLY IN A STILL AIR. IF THE VESSEL IS NOT SUFFICIENTLY RIGID TO RETAIN ITS SHAPE AT THE ABOVE TEMPERATURE, THE HEATING SHALL TAKE PLACE AT 1000 DEG. FAHR. FOR A TIME AT LEAST PROPORTIONAL TO THREE HOURS PER INCH OF THICKNESS.

ANY ONE OF THE FOLLOWING METHODS OF DETERMINING THE EXTENT OF HEATING IN STRESS RELIEVING WILL BE CONSIDERED SATISFACTORY:

a HEATING THE COMPLETE VESSEL AS A UNIT

b HEATING A COMPLETE SECTION OF THE VESSEL (HEAD OR COURSE) CONTAINING THE PART OR PARTS TO BE STRESS RELIEVED BEFORE ATTACHING THE SECTION TO OTHER SECTIONS OF THE VESSEL

c HEATING A CIRCUMFERENTIAL BAND HAVING A MINIMUM WIDTH OF *W* AS SHOWN IN FIG. U-3, IN SUCH A MANNER THAT THE ENTIRE BAND SHALL BE BROUGHT UP TO THE UNIFORM TEMPERATURE REQUIRED FOR STRESS RELIEVING.

PAR. U-73. RENUMBER THIS PARAGRAPH AS U-74 AND REVISE TO READ:

U-73. *Distortion.* The cylinder or barrel of a vessel shall be [substantially] circular at any section WITHIN A LIMIT OF 1 PER CENT, and if necessary to meet this requirement shall be reheated, rerolled or reformed.

PAR. U-74. RENUMBER THIS PARAGRAPH AS U-75 AND REVISE TO READ:

U-74. *Dished Heads.* Dished heads convex to the pressure shall have a flange not less than $1^1/_2$ in. long and shall be inserted into the shell with a driving fit and welded as shown in Fig. U-$3^1/_2B$.

Dished heads concave to the pressure shall have a length of flange not less than 1 in. for shells not over 24 in. in diameter. For vessels over 24 in. in diameter this length shall be not less than $1^1/_2$ in. [It is, however, recommended that the length of flange shall be not less than 12 per cent of the diameter of the shell.]

When the heads are thicker than the shell they shall be reduced in thickness as shown in Figs. U-$3^1/_2A$ or U-$3^1/_2/B$.

PAR. U-75. RENUMBER THIS PARAGRAPH AS U-76.

PARS. U-76 AND U-77. REPLACE BY NEW PAR. U-77 TO READ AS FOLLOWS:

U-77. *Inlet and Outlet Connections.* Pipe connections may be made as provided for in Par. U-59.

Nozzles which are attached by fusion welding shall be formed and welded in accordance with Fig. U-3.

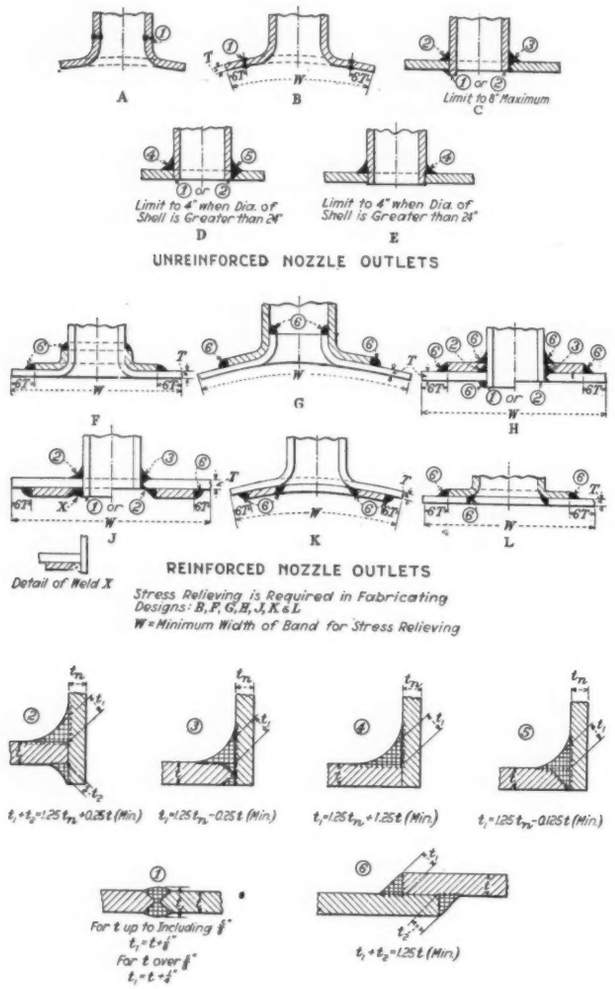


FIG. U-3

Nozzles may be fusion-welded, with or without reinforcement, to the shell or to the spherical portions of the head (see Fig. U-3). When the inside diameter of the vessel is 36 in. or greater, the inside diameter of an unreinforced fusion-welded nozzle shall not exceed that given in the following equation:

$$d = 0.1155 \frac{D}{K} \sqrt{6K - 5K^2 - 1}$$

where d = maximum allowable inside diameter of nozzle, in in.
D = inside diameter of shell, in in.
K = ratio of computed stress in the solid plate to one-fifth of the ultimate tensile strength stamped on the plate, $= \frac{PR}{St}$.

Fusion-welded nozzles which require reinforcement may be of the reinforced type as shown in Fig. U-3. Nozzles of the type shown in Fig. U-3*K* shall be designed in accordance with the rules for manholes given in Pars. U-55, U-56, and U-57. For other reinforced nozzles, the thickness of the reinforcing pad may not be less than that given in the following equation:

$$t = T \left[3.75 \frac{d}{D} - 0.525 \frac{(1 - K)}{K} \right]$$

where t = required thickness of pad, in in.
T = thickness of shell or head, in in.
d = inside diameter or nozzle, in in.
D = inside diameter of shell, in in.
K = ratio of computed stress in the solid plate to one-fifth of the ultimate tensile strength stamped on the plate $= \frac{PR}{St}$.

The thickness of the reinforcing pad shall not be less than $^3/_4$ in. when the thickness of shell or head to which the same is fitted is 2 in. or less; when thickness of head or shell is greater than 2 in., the minimum thickness of the pad shall be 1 in. The width of the pad along the longitudinal axis of the shell or any axis of a head, shall not be less than the inside radius of the nozzle less the nozzle thickness.

Nozzles which are attached by fusion welding in vessels whose

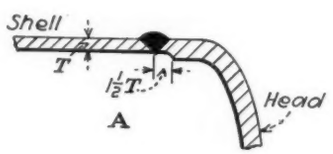


FIG. U-3$^1/_2$A

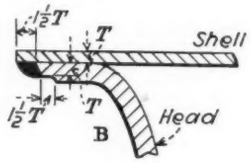


FIG. U-3$^1/_2$B

seams are of riveted construction shall be attached prior to the making up or attachment of the courses by riveting, or if they do not require stress relieving, shall have such nozzles located at a distance from the riveted seam equal to the diameter of the nozzle plus 4 times the shell plate thickness.

PAR. U-87. REVISE SIDE HEADING AND FIRST SENTENCE TO READ:

U-87. *Stress Relieving.* [Annealing.] After welding, the ENTIRE [whole] vessel or cylinder shall be heated UNIFORMLY AND [to a] THE temperature INCREASED SLOWLY AT LEAST 1100 DEG. FAHR. AND HELD AT THAT TEMPERATURE FOR A TIME AT LEAST PROPORTIONAL TO ONE HOUR PER INCH OF THICKNESS [sufficient to remove the internal strains], and SHALL [then] BE allowed to cool slowly in A STILL AIR [the air]. IF THE VESSEL IS NOT SUFFICIENTLY RIGID TO RETAIN ITS SHAPE AT THE ABOVE TEMPERATURE, THE HEATING SHALL TAKE PLACE AT 1000 DEG. FAHR. FOR A TIME AT LEAST PROPORTIONAL TO THREE HOURS PER INCH OF THICKNESS.

PAR. U-88. IN THE THIRD AND FOURTH PARAGRAPHS OF THE REVISED FORM OF THIS PARAGRAPH SHOWN IN OCTOBER, 1929, ISSUE, REPLACE "*E*" IN THE FORMULA BY "*K*," AND CHANGE THE DEFINITION OF "*E*" TO READ AS FOLLOWS:

K [*E*] = RATIO OF COMPUTED STRESS IN THE SOLID PLATE TO ONE-FIFTH OF THE ULTIMATE TENSILE STRENGTH STAMPED ON THE PLATE $= \frac{PR}{St}$ [computed stress in solid plate / maximum allowable stress].

MODIFY REVISION OF LAST SECTION TO READ:

The thickness of the reinforcing pad shall not be less than $^3/_4$ in. when the thickness of shell or head to which the same is fitted is

2 in. or less; when thickness of head or shell is greater than 2 in., the minimum thickness of the pad shall be 1 in. The OUTSIDE DIAMETER [width] of the pad [along the longitudinal axis of the shell] shall not be less than TWICE the inside DIAMETER [radius] of the nozzle [opening].

Procedure for Fusion Welding of Pressure Vessels—

Under Chapter II on Design, revise fourth sentence to read as follows:

Furthermore, in the design of welded vessels care should be taken to so locate the welded joint that the bending stresses that are inevitable in certain shapes of structures will not be brought directly upon the welded joint; as an instance may be cited the case of dished heads on cylindrical vessels, in which the weld should not be applied directly ON THE CURVED PORTION OF [at] the knuckle of the head.

Under Chapter III on Construction, omit the last paragraph which pertains to the attachment of dished heads.

PAR. I-8. REVISED:

I-8. *Inspections of and Allowances for All Plates Subject to Pressure.* All plates [material] shall be examined for surface defects such as scale, depressions and laminations [it may be accepted provided that in no case shall a] plates MAY be accepted having [a] depressions [greater than] not OVER [exceeding] 4 in. in [its greatest] length OR A DEPTH NOT EXCEEDING 15 per cent of THE [its] thickness OF THE PLATE [and], if [depressions are found] UPON careful measurement OF THE DEPRESSIONS IT IS FOUND THAT [shall be made, and if by reason of] the reduced thickness DOES NOT LEAVE the plate [is not] weaker than where machined for rivet holes or tube holes. Plates that are found laminated shall be rejected.

Work of the A.S.M.E. Boiler Code Committee

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretations of the Committee in Cases Nos. 633, 642, 643, 644, and 645, as formulated at the meeting on February 20, 1930, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 633

Inquiry: Is it necessary, under the requirements of Par. U-71 of the Code, where single- and double-V type welded joints are referred to, to bevel the edges of the plate in all cases before welding? Attention is called to the carbon-arc process in which it is the customary practice to weld joints in plates up to 3/4 in. thickness without any beveling or previous preparation of the plate edges.

Reply: Welds made by the carbon-arc process that do not require beveling the plate edges in advance may be considered the equivalent of single- or double-V welds made by other fusion welding processes, provided that scientific data which demonstrates from adequate physical tests the efficiency of the welding process is presented to the Boiler Code Committee.

CASE NO. 642

Inquiry: Is it necessary to make the back pitch of rivets in a circumferential joint the same as in a longitudinal joint of a drum in accordance with Par. P-182, or can the back pitch be made less in the circumferential joint, provided the efficiency of the circumferential joint is at least half of that required for the longitudinal joint or ligament?

Reply: If the stress due to pressure on a circumferential joint together with any stress through weight components due to supporting the boiler, can be withstood with a factor of safety of 5 for the ligaments between the rivets which come in a circumferential direction, as well as for the ligaments between the rivets which come in a diagonal direction, it is the opinion of the Committee that it is not necessary to apply the requirements for back pitch given in Par. P-182.

CASE NO. 643

Inquiry: Is it the intent of the rules in the Code for dished heads, that the thickness of the plate ordered for forming shall be sufficient to maintain the required thickness at the corner radius of the knuckle where it may thin down between 5 and 10 per cent, or is the factor of safety provided for heads sufficient to take care of this thinning in the case of plain heads as well as manheads?

Reply: It is the opinion of the Committee that the required thickness for dished heads as determined by the formulas in the Code is sufficient to provide for the thinning down at the corner radius of the knuckle for plain heads as well as for manheads.

CASE NO. 644

Inquiry: Is it permissible to classify steel made by the electric furnace process as the equivalent of open-hearth steel as required in the specifications in the Code for rivet material? It is pointed out that action has been taken by the American Society for Testing Materials ruling that steel made by the electric furnace process is acceptable in specifications that call for open-hearth steel.

Reply: It is the opinion of the Committee that steel made by the electric furnace process will be acceptable under the Code in specifications requiring open-hearth steel, provided all other requirements of the specifications are met.

CASE NO. 645

Inquiry: Is it the intent of Par. P-182 of the Code and Case No. 301 interpreted thereon, that the back pitch shall be measured on the median line of the shell plate and the rivet holes projected therefrom to the inner and outer butt straps without regard to the corresponding measurements on the straps?

Reply: As pointed out in the reply in Case No. 301, the back pitch on thick shell plates is measured on the shell plate, either on the plate before rolling or on the median line after rolling, and it is the opinion of the Committee that the back pitch as there measured will govern the locations of the rivet holes in the butt straps.

The Conference Table

THIS Department is intended to afford individual members of the Society an opportunity to exchange experience and information with other members. It is to be understood, however, that questions which should properly be referred to a consulting engineer will not be handled here.

Inquiries will be welcomed at Society headquarters, where they will be referred to representatives of the various Professional Divisions of the Society for consideration. Replies are solicited from all members having experience with the questions indicated. Replies should be as brief as possible. Among those who have consented to assist in this work are the following:

ARCHIBALD BLACK, Aeronautic Division
A. L. KIMBALL, Applied Mechanics Division
H. W. BROOKS, Fuels Division
R. L. DAUGHERTY, Hydraulic Division
WM. W. MACON, Iron and Steel Division
JAMES A. HALL, Machine-Shop Practice Division
CHARLES W. BEESE, Management Division
G. E. HAGEMANN, Materials Handling Division
J. L. WALSH, National Defense Division
L. H. MORRISON, Oil and Gas Power Division
F. M. GIBSON and W. M. KEENAN, Power Division
W. R. ECKERT, Petroleum Division
MARION B. RICHARDSON, Railroad Division
WINFIELD S. HUSON, Printing Industries Division
JAMES W. COX, JR., Textile Division
WM. BRAID WHITE, Wood Industries Division

Wood Industries

Treating Wood for Use in Lining Refrigerator Cooling Rooms

WI-4 Coniferous, odorless woods are used as linings of refrigerator cooling rooms. How can these woods be impregnated in such a manner as to keep them from absorbing moisture and at the same time not impart an odor or other undesirable condition?

During some research work on wood filter frames for a chemical plant, the following process was chosen for prolonging their useful life: The wood was immersed in a bath of liquid paraffin wax for 24 hr. at a temperature of about 110 deg. fahr. The bath was then allowed to cool to a point just before solidification of the wax, and then the wood was removed and cooled. (Leonard R. Mackay, Coatesville, Pa.)

Management

Efficiency of Industrial Workers

MG-3 What is the average efficiency of industrial workers when employed on a straight day-wage basis as compared to the average efficiency of similar workers employed on a scientific wage-incentive plan?

While employed at the White Motor Company, Cleveland, the writer personally made a study of the question, and was able to get actual figures over a period of three months on a group of about 150 men who were employed on motor-assembly work. The result of this survey indicated that the average efficiency while employed on day work was 41.6 per cent. After the men were placed on a scientific bonus plan, the efficiency immediately jumped to 93 per cent.

Since obtaining the figures mentioned above, the writer has made a study on 28 different jobs in the manufacture of airplane parts, the total standard time of which as determined by scientific time-study analysis is 1608 min. The day-work time for these same jobs was 3408 min., showing an average day-work efficiency of 47 per cent.

The jobs referred to cover a wide range of operations requiring a diversified grade of skill, speed, and strength. The following operations, expressed in shop parlance, were covered: Drill, form, bore and snip, trim and cut off, assemble, drill and rivet, squeeze sides, lay and waterproof cloth, stencil, drill and tack, nibble, mark and snip, tack weld, weld, and dope. (E. P. Campbell, Manufacturing Department, Great Lakes Aircraft Corporation.)

Miscellaneous

Bending a Heavy I-Beam

M-3 It is proposed to bend a 9-in. I-beam of heavy section to a radius of 11 ft. 3 in. What methods are recommended to accomplish this without destroying the shape of the web of the beam?

a Under similar conditions a gray-iron or steel casting has been made to take the place of the bent structural-steel section. It is difficult and expensive to bend a 9-in. I-beam to a radius of 11 ft. 3 in. If gray iron is strong enough for the purpose, it is much cheaper than cast steel. The strength of cast steel is approximately the same as that of structural steel.

The writer has also substituted welded sections for bent structurals and has made quite a saving both in time and money. An I-beam section can be built up of one plate for the web and two plates for the flanges. Each piece can be bent separately and then assembled as shown in the accompanying illustration (Fig. 1).

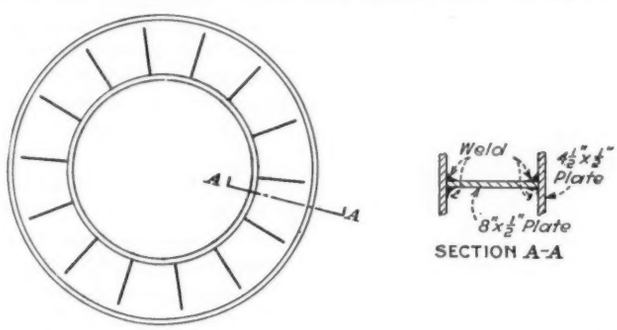


Fig. 1 Circular I-Beam Section Built Up by Welding

The method which is best to use will depend on the use to which the piece is put and the quantity required. (James Winston, Elizabeth, N. J.)

b The problem of bending a 9-in. I-beam consists of finding a means for shifting the neutral axis of the beam inward toward the concave flange so that compressive stresses will not be excessive.

There are three ways of doing this: (1) By removing metal from the outer flange by cutting slots or punching holes therein each side of the web; (2) by heating the web and outer flange to a much higher temperature than the inner flange before bending; and (3) by adding an axial pull to the beam so as to reduce the compressive and increase the tensile stresses and "stretch" the beam as it is bent.

As a practical job some combination of (1) and (2) seems to be the most logical. One-quarter inch can be machined off the face of the outer flange, and still more metal removed by punching a double row of $^3/_4$-in. holes each side of the web if desired. (See Fig. 2). Then the flange and the web should be heated.

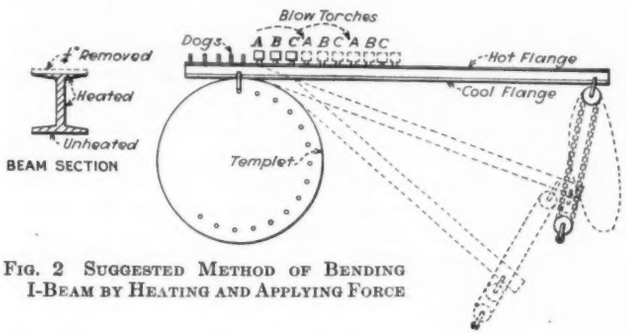


FIG. 2 SUGGESTED METHOD OF BENDING I-BEAM BY HEATING AND APPLYING FORCE

Normal conductivity will provide a sufficient flow of heat into the inner flange, which is to be kept relatively cool. Then by bending the beam around a floor templet by a purchase attached to the cooler inner flange, the necessary flexure can be secured without buckling the web. No downward crushing force should be applied to the outer, softer flange, as it is best to have this portion of the beam under tension only. Local heating by blow torches near the point of tangency with the templet would also help. Shop facilities will dictate the exact procedure, and if no material may be removed from the outer flange, a set-up using method (2) will have to be worked out so that maximum speed in bending and greatest extremes in the temperatures of the two flanges is obtained.

The outer flange, after bending, will be about 13 per cent narrower than normal, and the web near the outer flange about 10 per cent thinner. Any holes punched in the outer flange will be elongated and must be reamed before they are riveted. (Richard D. Karr, Structural Engineer, Department of Building and Safety, City of Los Angeles, Calif.)

Questions to Which Answers Are Solicited

USE OF PULVERIZED COAL FOR FIRING SHAFT LIME KILNS

F-14 Has a direct-fired pulverized-coal system ever been used to fire shaft lime kilns? If so, give brief description, results obtained, difficulties encountered, and data on operation.

ETCHING NUMBERS ON THICKNESS GAGES

M-13 What is an inexpensive method of etching numbers on thickness gages? A rubber stamp dipped in acid has been tried, but with acid strong enough to etch the impression clearly, the rubber stamp is corroded.

CUTTING A GROOVE IN HARD ROCK

M-14 How can a groove $^1/_2$ in. deep and from $^1/_2$ in. to $^3/_4$ in. wide be machined at one cut in hard rock at a speed of 60 in. to 75 in. per min.? What power will be required, and what material and shape is necessary for the tool?

CAUSES AND REMEDIES FOR CINDER CUTS IN BOILER FLUES OF LOCOMOTIVES

R-4 What are the causes and satisfactory remedies for cinder cuts in the flues of steam locomotives? They occur both inside the firebox above the firebricks at the boiler head and also in the front end or smokebox.

Correspondence

Development of the Deep-Well Turbine Pump

TO THE EDITOR:

In the November issue of MECHANICAL ENGINEERING there appeared a paper by W. H. Holcomb on "The Development of the Deep-Well Turbine Pump," which paper was presented at a meeting of the San Francisco Section in June last.

The statement of Mr. Holcomb that the first deep-well turbine pump on record was a unit installed in Chicago by Byron Jackson in 1901 is in error. , Mr. Jackson built his first pumps for the writer about 1903, and they were installed at the plant of the Pabst Brewing Company in Milwaukee. These pumps were designed at the writer's suggestion, the precedent being certain pumps made by Farcot of Paris, and installed in the Moscow (Russia) water works.

DANIEL W. MEAD.[1]

Madison, Wis.

[The foregoing communication was submitted to Mr. Holcomb, the author of the paper in question, who writes that his original manuscript was based on information which at the time appeared to be authentic, but that the results of a further investigation that he has made confirm Professor Mead's statement.—EDITOR.]

The Economic Status of Engineers in the Federal Service

TO THE EDITOR:

The article in the February issue of MECHANICAL ENGINEERING, entitled "The Economic Status of Engineers in the Federal Service," is misleading in regard to the hours of duty in the Federal Service. To a very large extent the weekly hours of duty are 48 instead of 42 during the winter, and the reduced hours of duty in the summer time—thanks be to Theodore Roosevelt many years ago—are 44 instead of 39 as stated.

This report of the Washington Section of the A.S.M.E. was intended to apply to the District of Columbia only. There are many other establishments in the Federal Service in various parts of the United States that employ professional engineering help, and it is a notorious fact that the shorter hours apply only in Washington. Uninformed and younger members of the A.S.M.E. should not be misled.

The writer is not now in the United States Civil Service. He has served the Government in the past at the Naval Gun Factory, Washington, at the New York Navy Yard, and at Picatinny Arsenal, Dover, N. J., and he resigned each time in order to accept more remunerative and agreeable employment elsewhere.

O. C. THOMPSON.[2]

Mountain Lakes, N. J.

[1] Of Mead & Seastone, Consulting Engineers. Mem. A.S.M.E.
[2] Mem. A.S.M.E.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

BY-LAW: The Society shall not be responsible for statements or opinions advanced in papers or . . . . printed in its publications (B2, Par. 3).

The "American Machinist"

FIFTY years ago, through the enterprise of the publisher and editor of the *American Machinist*, an opportunity was afforded a selected group of engineers, under the leadership of John E. Sweet, to discuss the desirability of forming an association of mechanical engineers. This meeting which resulted in the formation of the A.S.M.E. was announced in the March 6, 1880, issue of that journal. In commemoration of this event, and in connection with the Fiftieth Anniversary Celebration of the A.S.M.E., the *American Machinist* once again, on Saturday, April 5, acted as host to the Society. It also published a special number, beautifully designed and significantly illustrated, containing, as a supplement, a facsimile of that memorable issue of fifty years ago. The publishers and editors of the present journal have once more done a great service to mechanical engineering. It is a pleasure to express appreciation of this splendid issue of the *American Machinist*, and of the whole-hearted support that its publishers and editors have always given in the interests of engineering.

Cooperation Gratefully Acknowledged

DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*, and the members of his staff, at considerable personal sacrifice because of hurriedly changed plans, displayed last month a splendid spirit of cooperation which is hereby gratefully acknowledged. This well-known journal is printed by the Mack Printing Company of Easton, Pa., as is also MECHANICAL ENGINEERING. Because of the extra size of the Fiftieth Anniversary issue of MECHANICAL ENGINEERING published in April, it was necessary to ask Dr. Howe to advance the date of publication of his journal, a request to which he acceded promptly and courteously. Any one familiar with the problems involved in changing publication dates will appreciate the extra effort and personal sacrifices by all members of Dr. Howe's staff that were entailed by this splendid cooperation. The editorial staff of MECHANICAL ENGINEERING is deeply grateful.

Air-Transport Fare Reductions

LAST January marked an event of outstanding importance in air transport, namely, the reduction of passenger rates to approximately those of the railroads. In many cases the rates are now equal to railroad fare plus the Pullman charge. In other cases the rate is just a few dollars more, while in at least one case—New York to Chicago—the rate is actually $2.92 less than the cost of traveling by one of the twenty-hour trains.

The effect of the lower rates surprised even the most optimistic advocates of lower fares. Some of the large operators reported a passenger increase of about 300 per cent in the first several days of the new rates, while one operator (Transcontinental Air Transport) from January 1 to 13 averaged $9^1/_2$ passengers per day under the old rate as against $31^1/_2$ passengers per day for the remainder of the month after the reduced rates had become effective.

Among those familiar with air-transport cost it is universally agreed that the operators cannot avoid a loss at such low rates, even with the present volume of traffic. However, it is very important to point out that some lines are already losing less money at the new rate than they lost formerly. This is, of course, progress, but the real advantage of the low rate lies in the fact that operators are building up traffic and educating travelers to use the air. Thus they are striving to attain traffic volume, the first essential to financial success with any medium of transport. If the present rates are continued throughout the summer and passenger volume continues to grow, a very moderate increase in fares should make it possible for many of the operators to show modest profits.

ARCHIBALD BLACK.[1]

Wire-Rope Research

J. R. McCAUSLAND'S paper, published elsewhere in this issue, is a practical indication of the need in the wire-rope research proposed by The American Society of Mechanical Engineers. It also demonstrates that in an uncoordinated way, in so far as the engineering world at large is concerned, research in this field is under way and is yielding results. This and other papers and discussions at a preliminary conference of users and makers of wire rope held last fall under the auspices of the A.S.M.E. Research Committee and Engineering Foundation, brought to light many problems. Important information obtained by experience here and there but not generally available, and great willingness to exchange information among users and makers were revealed at this conference.

There have been individual exchanges of information on wire rope, and some wider dispersions of knowledge through articles in journals and meetings of associations or work of committees have been accomplished. The real need for concerted action, under unified, representative leadership, in accordance with a well-considered program, has been proved by a preliminary inquiry during the past year.

In total, much is known about wire ropes, but the scattered bodies of fact will become more useful if they can be assembled

[1] President, Black & Bigelow, Inc., Air Transport Engineers, New York, N. Y. Mem. A.S.M.E.

and analyzed. Study of present knowledge, supplemented by further inquiry, will disclose gaps in knowledge, besides those already perceived, which can be filled only by intelligently directed experimentation and, possibly, some basic research. Frank, cordial, well-supported cooperation among all parties at interest, under the auspices of organizations without commercial bias, is the best means to effect large savings, reduce risks, and bring about improvements in methods and equipment for handling, using, and inspecting wire rope, for the real benefit of user, maker, engineer, insurer, and the public. The American Society of Mechanical Engineers and Engineering Foundation have offered their aid and are ready to proceed. Assurances of cooperation already received indicate that others may be expected, and that this important project for helping many branches of industry and engineering can soon be in active progress.

The Photoelectric Cell

WHILE based on an entirely different principle, the photoelectric cell is a development of the original idea embodied in the selenium cell, namely, response to variations in light. Unlike the selenium cell, however, whose response is comparatively crude, the photoelectric cell can be made extremely sensitive. It has been already applied to a number of applications of various kinds. In the Holland Tunnel connecting New York City and Jersey City, it is used to detect fumes in the air which affect the cell by reducing the illumination striking it from a specially set lamp.

In Germany an even more ambitious use of it is made. There they have developed a method of train control in which a train passing a certain point cuts off the light to a photoelectric cell and in this way operates the various switches.

It is proposed to use the photoelectric cell as a protection for safes by locating sources of light at various points in the room. Any one then attempting to approach the safe will cut off the rays from one or more of these sources, which will actuate the cell in the safe door and signal the proper persons that a burglar is around. Of course if the burglar is clever enough he may be able to circumvent this by locating one or more lamps of his own in such a way that the photoelectric cell will not operate.

In mechanical engineering the applications of the photoelectric cell have not yet been numerous, and yet there are possibilities. It is therefore of considerable importance that the mechanical engineer shall study this little device and thoroughly understand its workings. The cell has already been developed to an extent where it is quite reliable in operation, and therefore it is not necessary for him to bother much with its underlying theory. He should, however, thoroughly understand the conditions under which it works, and particularly its great sensitivity, for the device apparently responds to extremely slight variations in lighting power, as shown, for example, by the fact that it is used for automatically sorting tobacco leaves for cigar manufacture. In this case the photoelectric cell matches colors and throws out of line all the leaves that are either too dark or too light. Its use for detecting fumes has been already referred to; that for detecting vibrations in running machinery is being studied.

Why No Engineer?

"THEY shall not be sought for in public counsel," wrote the son of Sirach more than two thousand years ago, and his words have been quoted ever since as a reproach to the engineer. True, he did add, "without these cannot a city be inhabited," and declared that "they will maintain the state of the world," but compared with the judge, the ruler, the prophet, priest, and poet, this creative servant of mankind is of small importance.

Encouragement has been given us recently to think that this order is changing. It has been found that two-thirds of the graduates of engineering schools eventually occupy administrative positions. In our generation we have seen engineers sought for in public counsel: they have become governors of states, and one a president of the United States. But these are exceptional cases.

In the list of names of those who constitute the advisory board of the Princeton School of Public and International Affairs, recently announced, no engineer's name appears. There are five lawyers, one financier, and one foreign service officer. Of these men the chairman of the board of our greatest manufacturing and engineering industries comes closest to having the engineer's point of view—and he was trained as a lawyer.

Yet this is an engineering age. The culture of our times is the culture of industrialism. Public and international affairs are themselves largely bound up with problems which are in the province of engineering—communication, transportation, armaments, industry, agriculture, and public health and works. The entire structure of modern civilization is based on engineering achievements, and functions through the intelligent administration of its technical complexity by these men who have revolutionized the daily life of the world; yet their voice is not sought for in public counsel.

He was a shrewd observer, this son of Sirach, when he said, "All these trust to their hands: and every one is wise in his work. . . . Their desire is in the work of their craft."

Perhaps after all it is this which binds engineers so closely: their narrow interest in the technical features of their work which makes them lose sight of the larger significance of what their social, economic, and political status might be if they once set about developing it.

The omission of engineers from the counsels of such an adventure in education as is being launched at Princeton is food for thought for teachers and leaders in engineering.

Federal Specifications and National Defense

THE prompt production of non-military supplies for the army and navy is an important consideration in the plans of preparedness for an emergency. As many of the items have peacetime uses, there should be agreement between the Government and industry so that the emergency requirements can be met quickly from commercial production without the delay and expense necessary to the change over to Government specifications. This agreement would obviate the need for storing quantities of special materials. The production capacity available without delay would give adequate protection for these items.

During the past twelve years since the close of the Great War, American industry has been at work building a procedure for the development and promulgation of national standards of material and dimension. The American Standards Association about which this activity centers is but the clearing house for the 43 national organizations which hold membership in it and the 448 organizations which subscribe to its procedure and methods and are cooperating in the movement.

As a large consumer of products of all kinds, the Government was very wise in creating the Federal Specifications Board to prepare uniform specifications for the several departments. Parts of these specifications are often of necessity detailed descriptions of dimensions and quality. In the writing of these specifications the Federal Specifications Board has abundant opportunity, therefore, (1) to cooperate with industry in its organized effort to develop American Standards, (2) to assure for itself adequate supplies, and (3) to assure at the same time the building up of large productive capacity in this country.

American Industry asks that the F.S.B. either make direct reference to existing American Standards in its specifications or copy them in the form of the official publication.

An unnecessary burden is placed on the purveying firms when well-known specifications are rewritten for no apparently good reason.

Certain aspects of the cooperation between the A.S.A. and the F.S.B. were discussed at the March, 1930, meeting of the A.S.A.

An abstract of this discussion appears on page 553 of this issue of MECHANICAL ENGINEERING.

Organized Research for Industries

THERE are two kinds of research, both extremely important but widely differing in methods, purposes, and in the mental attitudes of the researchers. When a company organizes a research department it is primarily looking to see its activities reflected in its dividends to stockholders. As an English writer expressed it, it is looking for truth, but only for enough of it to pay. The last decimals are therefore apt to be laid aside until some future date.

It must be understood, of course, that what has just been said is entirely relative. Companies blessed with ability to view the distant future are not at all averse to what might be called a "long-pull" investment in research, and undertake investigations whose practical value may not be at all apparent at the time when they are authorized. The Research Department of the General Electric Company is a conspicuous instance of this far-sighted scheme of commercial research. Nevertheless, it is clear that commercial companies can undertake what might be called fundamental research only in exceptional cases, particularly as it is extremely difficult to keep the results of such research confidential. To meet this situation, several ambitious programs have been developed of late for carrying out such research by some central organization for the benefit of the entire industry.

One of the most recent and perhaps best-organized attempts of this kind has been initiated by Engineering Foundation, of which The American Society of Mechanical Engineers is a member, namely, the Alloys of Iron Research. This undertaking is to critically review the literature dealing with iron and its alloys, and to conduct research in the basic field of iron metallurgy.

It is financially supported in part by contributions from companies interested in the metallurgy of iron as well as from outside organizations—for example, the Battelle Memorial Institute of Columbus, Ohio. The remainder of the financial support has been largely obtained through the recommendations and good offices of the American Iron and Steel Institute.

The new organization has established most friendly relations with such institutions as the Bureau of Standards, Bureau of Mines, American Foundrymen's Association, Society of Automotive Engineers, American Electrochemical Society, etc., and will act not only as an independent organization in itself but as a clearing house on research enterprises in this country and to some extent throughout the world, thus avoiding duplication and possibly materially assisting the work of researchers by facilitating their access to the literature of the subject. This last alone may become of tremendous importance, as valuable publications on the metallurgy of iron are already available in ten languages, scattered through magazines and books, many of which are not easily accessible. The matter of original research is still in a somewhat inchoate state, as Engineering Foundation is not yet in a position to finance such research. However, under its auspices and with the advice of its committees two such research programs are already under way: one at Lehigh, dealing with alloys of iron and silicon, and the other at Carnegie Institute of Technology, dealing with alloys of iron and manganese. As regards both of these groups of alloys, there is still considerable disagreement as to what might be called the general equilibrium diagram. Both at Lehigh and at Carnegie Institute new instruments for these particular researches have been developed, and it is confidently expected that much light will be thrown on the uncertain regions of the respective diagrams which will be of value to the entire industry because of the growing use of iron-silicate and iron-manganese alloys as additions in widely varying proportions.

According to the New York *Times* of April 4, the House voted on April 3—

> . . . . to create a Textile Foundation to spend and administer a fund of about $2,000,000 for scientific and economic research in the textile and allied industries.
>
> The vote was on a bill introduced by Representative Merritt, of Massachusetts, which provided that the Textile Alliance, a corporation formed immediately after the war to protect the American textile industry in purchases of dyes, should pay to the new foundation about $2,000,000, which it was supposed to turn over to the Government.
>
> Under the terms of the charter of the Textile Alliance, it was supposed to make no profits, but through its dealings immediately following the war to prevent a demoralization of the dye market, it actually came out more than $2,000,000 to the good.
>
> The bill provides for a board of directors of the foundation, to be composed of the Secretary of Commerce, the Secretary of Agriculture, and three individuals familiar with textile industry, to be appointed by the President for terms of two, three, and four years. The bill gives the directors wide powers in administering the fund, with the provision that an annual report be made to Congress.

A similar movement of importance has found expression in the Ontario Metal Industries Research Association in Canada. This undertaking is sponsored jointly by the metal industries of the Province of Ontario and the Ontario Research Foundation, but the active direction of the organization is completely in the hands of the industries themselves. The Foundation will provide laboratories, staff, and facilities, while the industries will bear the overhead and general expenditures of the experimental work. Special stress has been laid in the new organization on the practical application of this metallurgical research in plant practice.

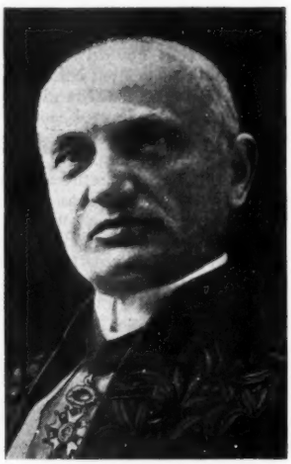
An extensive program of investigation has already been mapped out and the necessary preliminary work actively commenced. The research will be carried out along the following particular lines:

1. Macroscopic and microscopic examination and photography of metals, alloys, and, if necessary, other solid materials
2. Determination of melting points and critical points in steels and other alloys, and, under certain conditions, the checking of thermocouples
3. Chemical analysis of metallurgical materials
4. Mechanical testing of materials in tension, compression, etc., and also the conduct of hardness tests and the calibration of hardness-testing machines
5. General investigation of metallurgical processes, such as founding, forging, and rolling, with a view to possible improvement
6. Investigation of causes of failures in metal parts in service
7. Checking of methods of heat treatment of metals and alloys
8. Search for information already published in regard to metallurgical processes and the creation of a very complete metallurgical library for the use of members—for the elimination of unnecessary work and to provide accurate information.

Auguste C. E. Rateau

1863-1930

IN THE death of Auguste Camille Edmond Rateau, which occurred in Paris on January 13, 1930, The American Society of Mechanical Engineers has lost one of its most eminent foreign members; one who, passing at the comparatively moderate age of 67 years, might have been expected to continue longer in its work and its activities.



AUGUSTE C. E. RATEAU

Born at Royan, in the Department of Charente-Inférieure, on October 13, 1863, Auguste Rateau received his technical education in the famous École Polytechnique in Paris, being graduated at the head of his class (1881–1883), after which he passed three years at the École Supérieure des Mines, followed by a year of active service in the Government Mining Engineering Corps at Rodez. For the ten years between 1888 and 1898 he served as professor in the School of Mines at Saint Étienne, and during the years from 1902 to 1910 as lecturer upon industrial electricity in the High School of Mining Engineering at Paris.

It was during these latter years that Rateau began to devote his energies to his special inventions, and to their industrial and commercial development in France and elsewhere in Europe. The result of this work was the inception, with only five associates, in 1903 of the great Société Rateau, which, at the time of his death, engaged more than 4000 employees, with branches in most of the industrial centers of Europe. Of this great corporation he was the Chairman of the Board, and also actively and officially connecting with other industrial organizations.

As a professor he always exercised a most stimulating influence upon the students under his charge, while at the same time employing his original genius upon the subject of the mechanics of fluids and its application to steam turbines, to centrifugal compressors, and to centrifugal pumps. Centrifugal compressors of the Rateau type have come into general use in France and elsewhere for blast furnaces and steel converters; while his device of the steam accumulator has enabled the exhaust steam of reciprocating engines to be successfully utilized in low-pressure steam turbines.

In 1900 he published his treatise on turbo machines, a work which still retains its value for engineers in this department of practice.

During all the period in which Rateau was occupied with the development of the great industrial organization of which he was the head, he found time to conduct technical researches of fundamental value in the department of engineering to which he was devoted. The pages of the leading engineering publications of France are filled with communications of the highest scientific character from his fertile brain, and deal with turbo machines, pressure blowers, air screws, flow of gases through nozzles, ejector condensers, etc., etc.

More recently he gave much attention to the mechanics of aviation and the reactions of air resistance to the wings of airplanes.

Twice he was laureate of the Academy of Sciences, receiving the Fourneyron Prize in 1899, and the Poncelet Prize in 1911; at which time he was chosen a Member of the Institute of France, one of the highest honors to which a citizen of France may aspire; and to this was added that of Commander of the Legion of Honor.

When the Great War burst upon France, Rateau, although beyond the call for active military service, at once offered himself to the National Defense, and in connection with the Manufacture d'Armes at St. Étienne, he organized a model workshop, which under his able personal administration, produced more than four million shells. At the same time he developed his remarkable invention of the automatic supercharger for the motors of airplanes, enabling higher altitudes to be attained than had hitherto been possible, and thus giving French military airplanes a distinct advantage.

In connection with the ordnance department of the French army, Rateau developed improvements in the control of pneumatic recoil mechanism in artillery, of such importance that these devices have been kept secret by the government as valuable contributions to the national defense.

As an indication that his activities were unimpeded to the last, his latter days were devoted to the development of a most effective system of supercharging for the Diesel motor—researches of which the effects are yet to be made public.

Space will not permit an enumeration of the many contributions to engineering knowledge which have emanated from the fertile brain of Auguste Rateau—they fill a considerable volume, separately published, and sought and appreciated by the members of the profession; many of them are highly technical and analytical, showing an intimate knowledge of mathematical theory combined with practical application.

Many honors were conferred upon Auguste Rateau; it is necessary here to mention only that he received the doctorate from four institutions in as many countries: from America (University of Wisconsin), from England (University of Birmingham), from Belgium (University of Louvain), and from Germany (Technische Hochschule, Charlottenburg).

In all his active career, Rateau was always genial, courteous, and accessible, even to the least important members of his organization; never egotistical or dogmatic, always friendly and affectionate.

Often he repeated his controlling thought:

"Happy is he who succeeds in delivering his message!"

Auguste Rateau was elected Honorary Member of The American Society of Mechanical Engineers in 1919, and always manifested a great interest in its work and its members.

HENRY HARRISON SUPLEE.

Paris, France.

Clemens Herschel

1842–1930

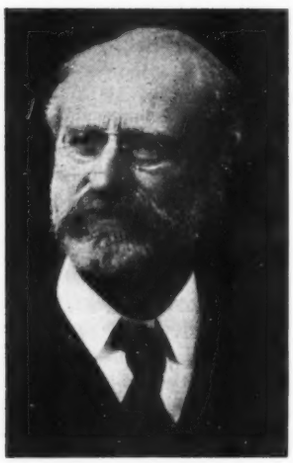
CLEMENS HERSCHEL, prominent American hydraulic engineer and inventor of the venturi water meter, died on March 1, 1930, at the age of 87, at his home in Glen Ridge, N. J. Mr. Herschel was born in Boston on March 23, 1842, and was graduated from the Lawrence Scientific School, Harvard University, in 1860. He studied in France and Germany, and was graduated from the Carlsruhe Technical School in 1863.

Mr. Herschel's career in hydraulic engineering began in 1879 when he became associated with James B. Francis in the work of the Holyoke Water Power Co. He rebuilt the dam across the Connecticut River, selling the water power thus developed to various local mills on a scientific basis, and operated the famous Holyoke testing flume.

During the period of his life from 1879 to 1889, Mr. Herschel also devised the now famous venturi meter which he named for the famous Italian Venturi who many years before had established the theory upon which the instrument was based. For a paper presented before the A.S.C.E. describing this notable contribution to engineering, Mr. Herschel was awarded the Rowland prize in 1888, and for the invention the Franklin Institute of Philadelphia awarded him the Elliott Cresson Medal.

In 1889 Mr. Herschel became hydraulic engineer of the East Jersey Water Co., building works to provide a large additional water supply for Newark and other New Jersey communities. These works included dams and reservoirs on the Pequannock River, a riveted steel pipe line, and several venturi meters. His work with the East Jersey Water Co. continued until 1900. His consulting practice also included such projects as those at Niagara Falls and the deep pressure aqueduct beneath New York City.

Mr. Herschel wrote many books and articles on engineering subjects. As a result of his pre-hydraulic practice he published in 1875 a book on "Continuous Revolving Drawbridges." In 1897 he published a book on "115 Hydraulic Experiments," and in 1899 a translation of an engineering classic "Two Books on the Water Supply of the City of Rome," by Sextus Julius Frontinus. He also contributed to the engineering journals and to the American Society of Civil Engineers.



CLEMENS HERSCHEL

In 1920 Mr. Herschel read a paper before the A.S.M.E. on "An Improved Form of Weir for Gaging in Open Channels," in which he described the application of the principle of the venturi meter to the weir.

Mr. Herschel was a member of the Boston Society of Civil Engineers; the American Society of Civil Engineers, of which he was vice-president, and because of the death in office of E. L. Corthell, president, 1915–1916; the American Water Works Association; and the Institution of Civil Engineers.

Shortly before his death, Mr. Herschel wrote about his work at the Holyoke Testing Flume in a letter to Mr. Arnold Pfau of the Allis-Chalmers Company of Milwaukee, a company which he had served a quarter of a century ago as the first manager of its hydraulic engineering department. Through the courtesy of Mr. Pfau and Mr. William Monroe White, excerpts from Mr. Herschel's letter are quoted below.

Broadly speaking [Mr. Herschel wrote], the year 1880 coincides in date with the beginning of the study by the public of the efficiency of hydraulic turbines, and preceded by about 10 years their being built to order to fit the particular requirements of the buyer as to power and speed. There were indeed on record before those years the beautiful tests of certain wonderful Boyden turbines, tested and installed at the Tremont Mills in Lowell, Massachusetts, in the 50's, as laid down in that sterling volume, "Lowell Hydraulic Experiments," by that sterling hydraulic engineer, James Bicheno Francis, Agent of the Proprietors of the Locks and Canals on Merrimack River in Lowell, but it all was way above the heads of all but perhaps half a dozen men in the whole United States. And as for building special wheels to order, that cost too much, and only Boyden could do it. The thing to do was to go to a "wheel builder," a branch of a general machine shop, which built cast-iron turbines as it would shelf hardware, and kept them in stock in a "wheel-yard;" pick out your turbine, and if the speed was not right, then gear it up, or gear it down, as might be wanted.

Even so, the "head and fall" catered to was seldom over 25 or 30 ft.; never over 100; nor the power over 100 hp. If the available head was more than some 20 ft., it was cut up, by building several "levels" of canals, as at Holyoke, Mass.; or wasted, as at Niagara Falls prior to 1890.

Out in California, where the gold miners did all kinds of novel things, a mechanical genius by name of Pelton, did, in the early gold-mining days, drive a hurdy-gurdy wheel under a high head by means of a stream of water issuing from a hose and nozzle, but evidently that couldn't be done in a mill, and was generally inapplicable to a settled community.

Thus between 1847 and 1900, when building turbines to order may be said to have become the rule, more than 60 varieties of cheap cast-iron American turbines, built under innumerable U. S. Patents, were developed.

About 1875, a retired sea captain, one of those Down-East Yankee jack-of-all trades produced habitually in that section of the U. S., by the name of Emerson, took it into his head that unsupported talk and brag by wheel builders had gone on long enough; and began to test turbines for efficiency in an old disused canal lock at Holyoke, Massachusetts. This soon developed into the no doubt well-remembered Holyoke Testing Flume, built under the direction of their hydraulic engineer, Clemens Herschel, by the Holyoke Water Power Co. about 1880; and conducted by it for some 20 years. Too much cannot be said in praise of the influence of this establishment on the art of turbine construction in the U. S., during those years. Turbine builders sent their product to it from over the whole country, and merely proving the worthlessness of many a fancied notion was rendering a great service to the art. But besides this, the Testing Flume developed the science of judging of full-size turbines from tests of models of such turbines, by the doctrines of similitudes, and continued its good work until the few remaining turbine builders had thoroughly learned their art and had even set up testing apparatus of their own.

Philadelphia had all along conducted a mild competition to the Lowell influence in the U. S. A native of France, named Geyelin, had designed and caused to be built several Jonval wheels, in competition with Boyden's outward-discharge, or Francis' proposed inward-discharge, Fourneyrons. In passing let it be noted that one of the most eccentric mortals that ever lived was this same Uriah A. Boyden. An old bachelor, he lived in the 60's in the uppermost story of Young's Hotel in Boston, and had his office in the top story of Joy's Building; and to save going down stairs, and up again, on the way from his room to his office, and vice versa, he had a bridge thrown across the narrow street that separated the two buildings at about the level of those two sets of rooms. All through a Boston winter, he wore, out of doors, coarse, unbleached linen trousers, a black swallow-tail coat, and a stove-pipe hat of ancient vintage, and no overcoat. In his will he left a sum of money as a reward to any one who would prove by experiment certain features in nature, possibly anticipating the Einstein notions of today, which he thought might exist.

An editorial in the New York *Sun*, entitled "Venturi Plus Herschel," appearing shortly after Mr. Herschel's death, commented upon his contribution to hydraulics. Quotations from the editorial follow:

In the death of Clemens Herschel hydraulic engineering lost a distinguished scholar and scientist who graciously named his most valuable invention for Venturi, the discoverer of its principle. It was in 1791 that the famous Italian experimenter Giovanni Venturi found that when a liquid flows through a pipe which is made smaller for a short part of its length the pressure within the small section will be greatly reduced and the velocity of the stream therein increased. Napoleon decorated Venturi for his achievements in science. The principle was used by Bourdon in France in an apparatus for measuring the velocity of air currents in mines.

One hundred years after Venturi Mr. Herschel conceived the idea of making his discovery applicable as a meter to measure the flow of water in pipes. He set up an experimental model in the famous testing flume at Holyoke, Massachusetts, which was the first hydraulic research laboratory in the United States and where the science of water power turbines had its inception. The meter here developed he then named for Venturi.

The venturi meter has no moving parts and involves no increase in cost of the pipe line. The recording mechanism and its placement represents the only added expense and, as in the case of the automobile, the speedometer has come to be an absolute necessity; so, whenever liquids or gases flow through pipes they are measured by the mechanisms developed, perfected and made applicable to practical use by Herschel.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the United Engineering Society as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Books Received in the Library

BALANCING OF ENGINES. By W. E. Dalby. Fourth edition. Longmans, Green & Co., New York, 1929. Cloth, 6 × 9 in., 321 pp., illus., diagrams, tables, $8.40.

A presentation of Professor Dalby's well-known method of solving balancing problems and finding balancing weights. Changes in the new edition include new chapters on the vibration of railway bridges and on the balancing of internal-combustion engines; a rewriting and extension of the chapter on locomotive balancing, as well as minor improvements and additions.

BEITRAG ZUR REGELUNG DER KREISELPUMPEN UND UNTERSUCHUNGEN ÜBER DIE THEORETISCHE UND WIRKLICHE FÖRDERHÖHE. By Wilhelm Siebrecht. (Forschungsarbeiten....heft 321.) V.D.I. Verlag, Berlin, 1929. Paper, 9 × 12 in., 25 pp., diagrams, 5 r.m.

The author reports on an experimental investigation of the comparative merits of various methods for regulating centrifugal pumps, by adjustable guide vanes, by clearance sluice valves, and by throttle valves. He also investigates the accuracy of various methods for calculating the theoretical lift of these pumps and obtains data of interest to designers.

DAMPFTURBINENSCHAUFELN. By Hans Krüger. Julius Springer, Berlin, 1930. Paper, 7 × 10 in., 132 pp., illus., diagrams, tables, 15 r.m.

A treatise on steam-turbine blades, based on long experience in their manufacture. After a brief discussion of profiles, the author takes up the requirements of blade materials, the selection of materials, the properties of the metals and alloys used, methods of working, damages during operation, and methods of testing and inspecting.

ELEKTROBETRIEB IN DER TEXTILINDUSTRIE. By Wilhelm Stiel. S. Hirzel, Leipzig, 1930. (Elektrizität in industriellen Betrieben, bd. 8.) Paper, 7 × 10 in., 652 pp., illus., diagrams, tables, 33 r.m.

A comprehensive survey of the advantages of motor drives for textile machinery. The various processes of spinning and weaving are taken up one by one, and the selection and application of motors discussed. The book is not only a textbook on a branch of electrical engineering, but also a useful treatise on textile machinery and processes.

ELEMENTS OF ENGINEERING THERMODYNAMICS. By James A. Moyer, James P. Calderwood, and Andrey A. Potter. Fourth edition. John Wiley & Sons, New York, 1929. Cloth, 6 × 9 in., 195 pp., diagrams, $2.50.

Aims to bring out the principles of the subject and the practical applications of those principles to steam turbines, internal-combustion engines, refrigeration, and similar subjects. The new edition has been revised and in part rewritten.

ENERGIEWIRTSCHAFT. By Michael Seidner. Julius Springer, Wien und Berlin, 1930. Paper, 7 × 10 in., 133 pp., diagrams, tables, 9 r.m.

An economic and engineering study of the costs of power generated by hydraulic and steam plants, and by combined plants. The elements of total cost are analyzed and methods for determining them are given.

GASEOUS COMBUSTION AT HIGH PRESSURES. By William A. Bone, Dudley M. Newitt and Donald T. A. Townend. Longmans, Green & Co., London and New York, 1929. Cloth, 6 × 10 in., 396 pp., illus., diagrams, tables, $15.

This book is to be regarded, the authors state, as completing the review of the principal researches on flame and combustion from the time of Robert Boyle to the present which was begun with their "Flame and Combustion in Gases," published two years ago. It is chiefly concerned with the researches that have been carried out during the past twenty years by Dr. Bone and his collaborators. That work comprised the study of hydrogen-air, carbonic oxide-air, and methane-air explosions at initial pressures between 3 and 175 atmospheres, with the development of suitable apparatus for the investigation. An extensive bibliography and a convenient summary of the principal data relating to compressibilities of gases are appended.

HEAT LOSS ANALYSIS. By E. A. Uehling. McGraw-Hill Book Co., New York, 1929. Cloth, 5 × 8 in., 241 pp., diagrams, tables, $2.50.

The heating value of the amount of coal that contains a pound of carbon is the same, within practical limits, for all coals of the same type. Taking advantage of this property, the author has developed simple formulas for calculating and analyzing the heat losses in a boiler plant. This book, which is intended for the boiler-operating staff, explains in simple language the processes of combustion and heat absorption, shows how the recorded data can be resolved into the corresponding heat losses, and describes methods for applying the results to control operations.

LUFTFAHRTFORSCHUNG, Vol. 5, No. 4; [Reports] by Erich Rackwitz and Alexander V. Philippovich. R. Oldenbourg, Munich and Berlin, 1929. Paper, 9 × 12 in., 26 pp., illus., diagrams, tables, 5.40 r.m.

Four reports on various aspects of the aircraft-fuel problem. The qualities upon which aircraft fuels are judged in Germany are described; the specifications of the principal nations are com-

pared in tables and graphs; and the influence of cold on the value of these fuels and the effects of sulphur are discussed.

MATERIALS HANDLING EQUIPMENT. By Edward J. Tournier. McGraw-Hill Book Co., New York, 1929. (Industrial Management series.) Cloth, 6 × 9 in., 371 pp., illus., diagrams, $4.

Intended as a guide to the prospective user of machinery for handling materials, this book discusses the results obtained by the use of the usual devices, the ways in which they have been adapted to different uses, and methods of selecting the proper devices for specific cases. A wide survey of current methods and equipment is provided.

METALL- UND LEGIERUNGSKUNDE. By M. v. Schwarz. Second edition. Ferdinand Enke, Stuttgart, 1929. Paper, 8 × 11 in., 383 pp., illus., diagrams, tables, 26 r.m.

This revised and enlarged reprint of the article on metals and alloys in Dammer's "Chemische Technologie der Neuzeit" is a remarkably full, compact description of these substances. A valuable feature is an alphabetical list of three hundred common alloys, with their compositions. An exceedingly valuable work of reference.

METALLURGY OF WHITE METAL SCRAP AND RESIDUES. By Edmund Richard Thews. D. Van Nostrand, New York, 1930. Cloth, 6 × 9 in., 383 pp., illus., diagrams, tables, $5.50.

The first American treatise on the production of secondary metals. The author gives much practical information on the smelting of tin, lead, aluminum, and other residues and scrap; on the design and care of furnaces and melting pots, on treating flue dust and flumes; on sampling, and on white-metal alloys. Particular attention is given to the needs of small smelters, but the book will be useful to all in the industry.

MÉTÉOROLOGIE DU RELIEF TERRESTRE, VENTS ET NUAGES. By Albert Baldit. Gauthier-Villars et Cie., Paris, 1929. Paper, 7 × 10 in., 328 pp., illus., 70 fr.

Simultaneous observations of weather conditions along aerial routes have shown that the weather at any given point is influenced by the configuration of the earth's surface and the nature of the soil. In the present work the author discusses the two effects of most importance to aviators, the action of the relief upon wind and clouds. He describes the methods and instruments used for studying this action, and gives an account of the information that has been obtained up to the present in this new branch of meteorology.

NAVIGATION OF AIRCRAFT. By Logan C. Ramsey. Ronald Press Co., New York, 1929. Cloth, 6 × 9 in., 237 pp., illus., diagrams, $4.50.

A practical textbook for aviators by an experienced officer of the United States Navy. Piloting, dead reckoning, and aerial astronomy are discussed, together with maps, instruments and the application of aerology to navigation.

LES ORIGINES DES CHAUDIÈRES.....1825–1885. By Paul Augustin Normand. Société d'Éditions Géographiques, Maritimes et Coloniales, Paris, 1929. (Reprinted from *Revue Maritime.*) Paper, 6 × 10 in., 139 pp., illus., diagrams.

Sets out in great detail the history of the development of the water-tube boiler from its appearance in Gurney's steam carriage down to the year 1885, when modern forms had their birth. Both English and French developments are treated very fully.

SHIPWAYS TO THE SEA; OUR INLAND AND COASTAL WATERWAYS. By Ernest S. Clowes. Williams & Wilkins Co., Baltimore, 1929. Cloth, 6 × 9 in., 196 pp., illus., $4.50.

Students of transportation and economics will find in this book a very convenient account of the development and present condition of American waterways. Each of the great systems is reviewed and the plans for their improvement and union into a great general system are discussed critically.

SPERRHOLZ. By Georg Christians and Ernst Gaber. V.D.I. Verlag, Berlin, 1929. Paper, 8 × 12 in., 23 pp., illus., 3 r.m.

Pamphlet containing two papers on the comparative merits of ordinary lumber and plywood. The first paper compares the technical and economic advantages of the two materials and discusses the uses of plywood. The second gives the results of extensive comparative tests of the mechanical properties of sawed lumber and plywood of the same wood. These papers are reprinted from *Maschinenbau.*

TECHNISCHE MUSEUM ALS STÄTTEN DER VOLKSBELEHRUNG. By O. v. Miller. (Deutsches Museum. Abhandlungen und Berichte, bd. 1, heft 5.) V.D.I. Verlag, Berlin, 1929. Paper, 6 × 8 in., 27 pp., illus., 1 r.m.

A brief discussion of the place of the technical museum in popular education, by the Director of the famous Deutsches Museum at Munich.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS, Twentieth edition, 1929–30. Thomas Publishing Co., New York, 1929. Cloth, 9 × 12 in., v.p., illus., $15.

Contains lists of manufacturers in all lines, arranged alphabetically and by products; and directories of trade names, commercial organizations, banks, and trade papers. The arrangement and scope are similar to that in previous editions, but the directories have been carefully revised. The largest work of its kind, and almost indispensable.

TIMBER DESIGN AND CONSTRUCTION. By Henry S. Jacoby and Roland P. Davis. Second edition. John Wiley & Sons, New York, 1930. Cloth, 6 × 9 in., 334 pp., illus., diagrams, tables, $4.50.

A revision of Jacoby's "Structural Details: or Elements of Design in Timber Framing." The authors discuss successively joints and fastenings used in framing, wooden beams and columns, and wooden roof trusses. A chapter is devoted to examples of framing in buildings, bridges, and other structures, and another to timber tests and unit stresses. The book gives a good account of the field for timber in construction and the best methods of using it.

LA TRANSMISSION DE LA CHALEUR. By M. Ten Bosch. Translated from the second German edition. Dunod, Paris, 1930. Paper, 7 × 10 in., 371 pp., diagrams, tables, 90.40 fr.

Aims to present our present knowledge of heat transmission in a form convenient for designers. The laws of radiation and conduction, the theory of heat transmission between two bodies, the coefficients of transmission of various substances are discussed and the practical applications of the theory to the design of condensers and boilers explained. Numerous tables give the coefficients of heat transmission for ammonia, carbon dioxide, water, oil, steam, and other ordinary fluids.

DIE WÄRMEAUFNAHME DER BESTRAHLTEN KESSELHEIZFLÄCHE. By Otto Seibert. (Forschungsarbeiten, heft 324.) V.D.I. Verlag, Berlin, 1930. Paper, 8 × 11 in., 17 pp., illus., tables, 4 r.m.

The high temperatures under which boilers are operated today have not only increased their efficiency, but have also increased the danger of injuries to the tubes. As these frequently occur at points subjected to direct radiation, the author has been led to investigate mathematically the absorption of radiant heat.

This paper presents a method for determining the amount of heat radiated to a surface, which agrees closely with actual measurements.

WÄRMEKRAFT UND WÄRMEARBEITS MASCHINEN. By A. Loschge. Akademische Verlagsgesellschaft, Leipzig, 1929. (Handbuch der Experimentalphysik, bd. 9, t. 2.) Cloth, 7 × 10 in., 362 pp., illus., diagrams, tables, 36 r.m.

The theoretical principles of steam engines, steam and gas turbines, boilers, internal-combustion engines, compressors, and blowers are discussed in the light of recent experimental researches in this field. The book, intended for university students, is a course in the theoretical mechanics of heat engines, in which modern conceptions are presented clearly, without undue detail.

DER WASSERBAU.....bd. 1. By Armin Schoklitsch. Julius Springer, Wien, 1930. Bound, 8 × 11 in., 484 pp., illus., diagrams, tables, 52 r.m.

The purpose of this book is to present a comprehensive, balanced description of present-day hydraulic engineering which will enable the reader to inform himself quickly upon any of its topics. The work will be completed in two volumes. The first discusses meteorology, hydrology and hydraulics, soils, building materials, water supply and sewerage. The text is concise and practical; the illustrations are numerous and well-chosen; and the work affords a good course in the subject.

WORKSHOP RECEIPTS; SUPPLEMENT, ALUMINIUM TO WIRELESS. E. & F. N. Spon, London, 1930. Cloth, 5 × 7 in., 458 pp., illus., 5s.

This supplement to Spon's well-known "Workshop Receipts' contains supplementary information on various topics that appear in the original four volumes, together with information on a variety of subjects not found in them. The material here assembled has been chosen for its usefulness to the craftsman and amateur.

YEARBOOK ON COAL MINE MECHANIZATION, 1929. By American Mining Congress. Edited by G. B. Southward. American Mining Congress, Washington, D. C., 1929. Fabrikoid, 6 × 9 in., 390 pp., illus., $3.

Contains papers and reports by mine operators on various phases of mechanical mining and loading equipment. The present status of mechanization, power, ventilation, pillar recovery, safety, and the effect of mechanized loading on mining methods are discussed. Reports are included on the status of mechanization here and abroad, on actual mining operations with loading and mining equipment, and on the types of equipment at present in use. A comprehensive bbliography for the years 1920–29 is given.

Synopses of A.S.M.E. Transactions Papers

THE papers abstracted on this and following page appear in the current issues of the Machine-Shop Practice and Petroleum sections of A.S.M.E. Transactions. These sections have been sent to all who registered in the similarly named Divisions. Other sections are in the course of preparation and will be announced when completed, in later issues of "Mechanical Engineering."

MACHINE SHOP PRACTICE PAPERS

INTERNAL GRINDING OF SMALL AND MEDIUM-SIZED HOLES. By Carroll R. Alden. [Paper No. MSP-51-15]

Details are given of bearing and spindle design valuable to those confronted with problems of high speed. Extraordinary accuracy and very high speeds are required in grinding very small holes. The general principles in the choice of grinder-spindle equipment are detailed.

DIAMONDS AS METAL-CUTTING TOOLS. By C. L. Bausch. [Paper No. MSP-51-16]

In this paper the author recites the history of the use of diamond tools in the plant of the Bausch & Lomb Optical Co., which he believes to be quite representative of the use of diamonds in general. Diamonds were first used in the turning of materials which were too hard for steel tools. Their next use was in obtaining high finishes on non-ferrous metals, and this was followed by their use on work requiring extreme accuracy. In all cases, high speed was obtainable, although heavy cuts have never been possible with diamond tools. Data are given regarding the proper selection and setting of diamonds in relation to the cleavage plane of the material, as well as on cutting speeds and feeds, life of diamond tools, limitations due to vibration, etc.

CARBOLOY. By E. G. Gilson and G. N. Sieger. [Paper No. MSP-51-17]

The paper discusses a new cemented tungsten carbide which bears the registered trade name of "Carboloy" and in which the cementing substance is cobalt. The physical properties of this material are characterized by extreme hardness, and a strength approximately half that of high-speed steel. As a material for cutting tools, when properly applied, carboloy may be used for machining substances which cannot be cut by ordinary tools, or which easily dull the present type of tool. Examples of these are given. It is shown that high cutting speeds are obtainable with carboloy and that there are inherent defects in modern machine tools, such as lack of rigidity in tool posts, excessive wear of tailstock spindles in lathes, because of the impossibility of proper lubrication, weakness in power-transmitting elements of the machines, and inadequacy of power available in standard types to drive them to the limit which carboloy tools will withstand.

PRECISION CYLINDRICAL GRINDING. By R. E. W. Harrison. [Paper No. MSP-51-18]

This paper reviews the process of evolution through which the art of precision cylindrical grinding has passed during the last seven or eight years. As the mechanical features of the machines and the wheels employed on them have been improved in efficiency, it has been realized that production is dependent upon the horsepower capacity of the tool, consequently the structure of the tool has been strengthened and improved, until today these tools are offered to users largely on their power rating. Work which was regularly handled on 5-hp. machines in 1920 and 1921, is today being produced in a proportionately reduced time on 15- and occasionally on 20-hp. machines.

There is still considerable work to be done, both by builders and users of grinding machines, in the direction of the further elimination of idle or non-grinding time between the work cycles. It is as true of the modern grinding machine as it is of any other machine tool that is only an earning unit while the grinding wheel is in contact with the work. At other times it is a liability, so that the efforts of the shop management and the production engineer should all be directed toward the elimination of unproductive movements on the part of the operator.

CEMENTED AND TUNGSTEN CARBIDE TOOLS. By Samuel L. Hoyt. [Paper No. MSP-51-19]

Considerable interest has been shown in the past few years in the new tool materials which have tungsten carbide as a base. The most promising field for the use of these tools is in machining materials which are so abrasive that ordinary tools are speedily worn away or lose their cutting edge, but which do not exert great pressure on the tool. The author points out that the economic value of cemented tungsten carbide is so great in many instances that it at

once justifies its use. In some others this will not be so marked and in still other cases its use will be less economical or not at all suitable. Among the latter applications may be mentioned finishing cuts on iron and steel, hogging cuts on steel, or, in general, cuts with heavy feeds and cuts which impose heavy pressures on the tool.

TUNGSTEN CARBIDE CUTTING TOOLS. By Henry J. Long and W. Paul Eddy, Jr. [Paper No. MSP-51-20]

Results are given in the fabrication of tools of tungsten carbide, and experiences are detailed of successful and unsuccessful attempts to apply them to various kinds of work. Readjustment of manufacturing practices must take place if there is to be a place in industry for tungsten carbide. The present high price may have its effect upon general adoption. The future of such alloys as factors in efficient manufacturing is asserted to be in the hands of the users of machine tools and not the makers of tool materials nor of the machine-tool builders. The rigidity and absence of vibration in the machine tool must continue, even as it grows appreciably older, to permit these materials to operate without chipping. An even stronger and tougher alloy may become necessary.

PROGRESS OF FLUID-FILM LUBRICATION. By A. G. M. Michell. [Paper No. MSP-51-21]

This paper discusses briefly problems of bearing design imposed by the increasing demands of modern practice, and shows how they are being met in bearings of the film-lubricated type, especially with respect to carrying high intensities of bearing pressure in journal bearings, and to increasing the durability of bearings by elimination of wear. Some commonly unrecognized factors controlling the lubrication of bearings are discussed, especially with respect to lubricants other than oil.

Some new types of bearings are illustrated and described.

PRESENT STATUS OF TUNGSTEN CARBIDE AS A CUTTING MATERIAL. Report of Sub-Committee on Machinability of the A.S.M.E. Special Research Committee on Cutting of Metals. By Frank C. Spencer. [Paper No. MSP-51-22]

This report describes various features of machine-tool construction that must be improved in order to get the full benefit of the new cutting material. Results are given of a survey to show how tungsten carbide is being used by several concerns. The committee feels that much development work is necessary before machines can be designed with full confidence that they will be suited to the additional demands which will be thrown upon them.

SYMPOSIUM ON METHODS OF MOTOR APPLICATION AND CONTROL. [Paper No. MSP-51-23]

The papers forming this symposium deal respectively with electric drive for planers, special drilling and tapping machinery, precision grinding machines, and lathes.

F. E. Cardullo first describes the types of electric motors adaptable to planer drive and states that because of superior electrical and mechanical advantages, practically all reversing planer motors are of the adjustable-speed direct-current type and fall into constant-voltage and variable-voltage classes. He describes these motors and their control apparatus and computes such factors as the loss of time due to reversal. He then compares the reversing-motor with belt drive. He closes with a description of the space-time diagram and its use in studying planer drive.

J. H. Mansfield discusses the application of motors and controls for special drilling, tapping, turning, boring, and facing machines. He compares the times required in the operation of a single-purpose turning and facing machine equipped with single-speed motor and the same machine equipped with a multi-speed motor. In discussing the application of electric motors to woodworking machinery he shows a double-end turning machine equipped with 15 motors.

R. E. W. Harrison traces the development of motor-driven precision grinding machines from the countershaft belt-driven type. He then discusses motor bearings and motor mountings. From a study of a load-cycle chart which shows (*a*) period in which stock is reduced at maximum rate of metal removal, (*b*) ending of metal-removing period and beginning of finishing operation, and (*c*) period for finishing and accurate sizing, the author shows what are the chief characteristics desired in a motor driving a grinding wheel. The paper closes with a brief discussion of "across-the-line" motors and its advantages.

Chas. L. Cameron deals first with methods of mounting motors on lathes and lists the difficulties which arise from lack of standardization of motors. He then points out why it is best for the manufacturer of the lathe to provide the motor to drive it rather than relying on the purchaser to buy the proper motor, and discusses the tendency to use motors larger than practically required, pointing out that the use of anti-friction bearings has reduced the power required to drive the lathe. The paper ends with a discussion of motor types and an expression of the desirability of developing an alternating-current, variable-speed, constant-horsepower motor.

PETROLEUM PAPERS

ECONOMICS OF HIGH-PRESSURE TRANSPORTATION FOR NATURAL-GAS PIPE LINES. By P. McDonald Biddison. [Paper No. PET-51-5]

To keep pipe sizes within limits which can be had in quantity and thereby avoid excessive premiums on pipe and costly delays in construction, higher pressures are being resorted to. This paper contains a large amount of information in tables and gives basic formulas for design of pipe lines using high pressures for natural gas. Costs are given for compressor stations and for pipe-line construction.

CURRENT PRODUCTION ENGINEERING PROBLEMS. By Hallan N. Marsh. [Paper No. PET-51-6]

The modern methods of drilling and of "bringing in" an oil well are given, using a definite well as an example of the succeeding operations. The precautions taken to conserve the oil and the gas and the methods in use to continue the flow at the best rate for obtaining maximum recovery are described. The safeguards used to prevent accident and the proper processes for reviving a well that has ceased to flow are stated.

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AIR PREHEATERS

Modern. Modern Air Preheaters (Neuzeitige Luftvorwaermer), H. Balcke. Waerme (Berlin), vol. 53, no. 1, Jan. 4, 1930, pp. 6–12, 6 figs. Different types of air preheaters, such as surface regenerative preheaters, and direct-fired air heaters, are described, and their applications discussed; advantages of Ljungström regeuerative preheater; comparison of different types.

AIRPLANE ENGINES

Cylinders, Heat Transmission in. Rate of Heat Transfer From Finned Metal Surfaces, C. F. Taylor and A. Rehbock. Nat. Advisory Committee for Aeronautics—Tech. Notes, no. 331, Jan. 1930, 21 pp. and 28 figs. partly on supp. plate. Progress report on investigations at Aeronautical Engineering Department, Massachusetts Institute of Technology, evaluate factors controlling rate of heat transfer to moving current of air from finned metal surfaces similar to those on aircraft-engine cylinders; effectiveness of fin does not decrease very rapidly until its distance from adjacent fins has been reduced to 1/9 or 1/10 in.; formula for surface without fin.

Design. Gaging Airplane-Engine Performance, J. H. Geisse. Soc. Automotive Engrs.—Jl., vol. 26, no. 2, Feb. 1930, pp. 221–224 and (discussion) 224–225, 1 fig. All factors exclusive of reliability can be evaluated so as to provide good basis for choosing engine; effect of changes in engine weight on operating cost; tables show effect of increased engine weight, operating cost, and operation-expense items that are affected; increasing weight of 200-hp. engine from 400 to 494 lb. would be justified provided increases in time between partial and major overhauls and total life could be correspondingly increased; engine resistance.

Diesel. Diesel Engines, W. G. Meyers. Aeronautics, vol. 6, no. 2, Feb. 1930, pp. 19–20, 70, and 72, 5 figs. Review of what has been done to date in developing Diesel or oil burning engine for high-speed and light-weight requirements of aircraft; opposed-piston type of oil engine developed by H. Junkers; troubles encountered in development of Diesel engines outlined by Morgan; technical features on Packard Diesel.

Fuel Pumps. New Gloster-Straussler Gasoline Pump (La nouvelle pompe à essence Gloster-Straussler). Air (Paris), vol. 11, no. 239, Oct. 15, 1929, p. 25, 1 fig. Details of gasoline pump of direct-feed type; fuel is brought directly from tank to carburetor by means of one fuel line.

Oil. Clerget 100-Hp. Heavy-Oil Engine (Le moteur Clerget 100 hp. a huile lourde). Aéronautique (Paris), vol. 11, no. 126, Nov. 1929, pp. 369–370, 3 figs. Details of 9-cylinder radial aircooled 4-cycle clerget oil engine for airplanes; each cylinder has fins and carries one intake and one exhaust valve; it uses gas oil which is of inferior calorific value to that of gasoline, but it can also function on fuel oil produced by distillation of tar.

AIRPLANE PROPELLERS

Efficiency Formulas. New Higher Coefficient of Efficiency for Propellers (Un nouveau coefficient caracterisant le rendement de la propulsion par helice), M. Roy. Aérnautique (Paris), vol. 11, no. 126, Nov. 1929, pp. 370–371. Formulas are derived for finding higher coefficient of efficiency for airplane propellers; fuel consumption in horizontal flight per kilometer traveled and per kilograms of total weight taken into account which are easily measured in flight tests.

Forging. Development of the Drop-Forged Metal Propeller, F. W. Caldwell. Am. Soc. Mech. Engrs.—Advance Paper, for mtg. Mar. 12, 1930, 5 pp. Development of type of propeller suitable for drop forging is discussed; selection of forged-steel blade of very high aspect ratio and great diameter with low camber ratios at tip, but with comparatively thick sections in inner part; eliminating fluttering tendency; designing first aluminum alloy propeller; improvements in methods of inspection; limit of life of blades not yet established; question of vibration.

Variable Pitch. Test of an Adjustable Pitch Model Propeller at Four Blade Settings, E. P. Lesley. Nat. Advisory Committee for Aeronautics—Tech. Notes No. 333, Feb. 1930, 15 pp., 11 supp. figs. Tests of adjustable-blade metal model propeller, both in free wind stream and in combination with model fuselage, at four settings of blades; model propeller is designed for uniform nominal pitch-diameter ratio of 0.7 and blade settings used correspond to nominal pitch diameter ratios of 0.5, 0.7, 0.9, and 1.1 at 0.6 radius; they may be considerably changed in setting from designed pitch angles and yet give excellent performance.

AIRPLANES

Aluminum Alloys for. Aluminum Casting Alloys in Aircraft, L. S. Reid. Aviation Eng., vol. 3, no. 2, Feb. 1930, pp. 11–13, 5 figs. Aluminum alloys, both cast and wrought are indispensable in aircraft construction; three common methods of casting aluminum alloys, namely, sand casting, die casting, and permanent-mold casting, are discussed; casting in permanent molds has many desirable points; casting engine-cylinder head and pistons; Army Air Service specifications for aluminum die casting; most die castings found in aircraft are accessories.

Design. Aircraft of the Near Future, W. Mitchell. Aeronautics, vol. 6, no. 1, Jan. 1930, pp. 12–14, 58, 60 and 64, 4 figs. Trend of aircraft production is outlined; passengers and freight should be carried in wings instead of fuselage; landing gear should be folded up when airplane is in flight; variable pitch propellers; superchargers; airplane structure; engine self-starters; blind flying; gyroscopic compasses; criticism of Graf Zeppelin; advantages of airships as airplane carrier.

Helicopters. See HELICOPTERS.

Load Factors. Criteria for the Structural Strength of Airplanes, A. S. Niles. Soc. Automotive Engrs.—Jl., vol. 26, no. 2, Feb. 1930, pp. 226–232 and (discussion) 232–234. Question of whether criteria used by Department of Commerce to determine adequacy of structural strength in submitted design, are necessary and sufficient is discussed; objections to change in specified load factors; more data on air-pressure distribution needed as well as structural expert attached to National Advisory Committee for Aeronautics; relative advantages and practicability of using stress analyses versus static tests as basis of approval of designs.

Metal Construction. Metalizing the Airplane, H. V. Thaden. Am. Soc. Mech. Engrs.—Advance Paper for mtg., Mar. 12, 1930, 7 pp. Advantages of metal airplanes; two basic schools of structural design, one making use of conventional type of framed structure and other monolithic type of structural design which in general is not amenable to conventional determinate analysis; important advantage of monolithic type; type of fuselage structure using transverse bulkheads but replacing longitudinals with sheet metal corrugated longitudinally; skin takes all of shear loads and chord loads; different wing structures; inspectability of interior of structural importance.

Record-Breaking. New Record-Breaking Airplane (L'Avion due nouveau record de distance). Aéronautique (Paris), vol. 11, no. 126, Nov. 1929, pp. 358–360, 4 figs. Description of Breguet Super-Bidon sesquiplane and arrangement of fuel in record-breaking flight of Costes and Bellonte from Paris to Tzitzikar; weight of plane empty only 1990 kg.; construction of light alloys; wing span 18.30 m.; 630-hp. Hispano engine.

Shock Absorbers. Shock Absorber Strut Embodies New Ideas in Design. Machine Design, vol. 2, no. 1, Jan. 1930, pp. 42–43, 3 figs. Design of Edgewater ring spring strut which combines all advantages of oleo strut with none of disadvantages of former types of landing gears such as oleo-pneumatic gear with its complicated design and high maintenance cost; strut is designed to take up part of its travel against oleo and remainder against new ring spring.

Sheet Steel for. Alloy Steel Sheets for Aircraft, J. B. Johnson. Iron Age, vol. 125, no. 7, Feb. 13, 1930, pp. 502–505, 7 figs. Three types of sheet steel used in aircraft described; how chrome molybdenum thin sheets are made for heavy airplanes; physical properties and heat treatment; effects of welding; vibration failure of sheet-steel fabricated fittings due to poor bending properties of steel; equal strength in length and breadth of sheets obtained by cross-rolling;

in welding alloy sheet-steel parts to be heat treated for maximum strength, one must get complete fusion of weld metal into corner of abutting sheets.

Stability. Centering and Stability of Airplanes (Centrage et stabilité des avions), M. Guibert. Aéronautique (Paris), vol. 11, no. 126, Nov. 1929, pp. 375–380, 3 figs. Law of action of transition; stability, maneuverability, and balance; best centering; relation between coefficients of balance of rudder, maneuverability and static stability; influence of constant quantity of transition; practical construction of curves. (Concluded.)

Wings, Variable-Camber. Dare Variable Camber. West. Flying, vol. 7, no. 1, Jan. 1930, p. 86, 4 figs. Dare monoplane which employs full-cantilever variable-camber wing composed of two rigid main spars tied together at tip and at two intermediate positions with compression spars, diagonally braced between cross spars with drag braces; on this rigid unit is built variable camber wing consisting of movable leading, center, and trailing sections; wing span 33 ft. 4 in. and wing chord is tapered 9 ft. to 4 ft. 6 in.; plane is 2-place open-land monoplane with Kinner K-5 90-hp. engine.

ALLOY STEEL

Anti-Corrosive. Recent Developments in Corrosion and Heat-Resisting Steels, R. Hadfield, T. G. Elliot and R. J. Sarjant. Chem. and Industry (Lond.), vol. 49, no. 4, Jan. 24, 1930, pp. 41T-51T, 11 figs. Development of noncorroding and heat-resisting steels; mechanical and physical properties of corrosion-resisting steels; photomicrographs; resistance to scaling and strength at high temperatures; industrial applications of corrosion-resisting and heat-resisting steels.

Heat-Resisting. Alloys That Resist Heat, T. H. Nelson. Iron Age, vol. 125, no. 6, Feb. 6, 1930, pp. 431–434, 3 figs. Selection of suitable material for heat resistance is not a simple problem; four classes of alloys available; corrosion and heat resistance are same problem; heat corrosion in domestic heaters; failure often due to chemical corrosion; special dependence on certain alloys; alloys for both corrosion and heat; special steel for valves; more nickel than chromium not essential.

ALLOYS

Aluminum. See AIRPLANES; ALUMINUM ALLOYS.

Bronze. See BRONZE.

Copper. See COPPER ALLOYS.

ALUMINUM ALLOYS

New. Recently Introduced Aluminum Alloys, W. C. Devereux. Mech. World (Manchester), vol. 87, nos. 2247 and 2249, Jan. 24, 1930, pp. 82–83 and Feb. 7, pp. 122–123. Jan. 24: Discussion of some recently introduced aluminum alloys, particularly R. R. 50, regarded especially by aircraft-engine industry as representing distinct advance in use of aluminum; comparison of properties; methods of successful casting of "Y" alloy and R. R. 50 alloy; forging and stamping; inspection of ingots after casting. Feb. 7: Discussion following presentation of paper is given. Abstract of paper presented before Instn. Production Engrs.

Temperature Effects. Tests on Influence of Temperature on Notch Toughness and Hardness of Aluminum Alloys (Versuche ueber den Einfluss der Temperatur auf Kerbzaehigkeit und Haerte von Aluminiumlegierungen), W. Schwinning and E. Fischer. Zeit fuer Metallkunde (Berlin), vol. 22, no. 1, Jan. 1930, pp. 1–7, 21 figs. Notched-bar tests at temperature varying from minus 190 to plus 200 deg. cent. show basically different behavior of aluminum alloys and steel; influence of temperatures on bending strength of plates was determined also by static bending tests with unnotched specimens at temperatures between 0 and 200 deg. cent.

AMMONIA

Superheated. The Flow of Superheated Ammonia, J. C. Reed and E. E. Ambrosius. Refrig. Eng., vol. 19, no. 2, Feb. 1930, pp. 45–55; see also Heat. Piping and Air Conditioning, vol. 11. no. 2, Feb. 1930, pp. 101–106, 10 figs. Object of investigation was to determine relation between friction factor and Reynolds' number when superheated ammonia is circulated in one inch, extra heavy, black, steel pipe under conditions of pressure and temperature similar to those encountered in refrigerating practice; description of test procedure; graphs illustrating results of investigation.

AUTOMOBILE ENGINES

Cylinders, Casting. Casting Cylinders in Green Sand, D. J. Campbell. Soc. Automotive Engrs.—Jl., vol. 26, no. 2, Feb. 1930, pp. 177–184, 20 figs. Methods employed in Wyant and Cannon Foundry Co., Muskegon, Mich., in casting cylinders in green sand; success in making more bulky cores for cylinder barrels and crankcase in green sand; two methods of molding one 6-cylinder block in green sand; possibilities of system; details of cylinders molded or suitable for molding in green sand; core-room and foundry layouts; comparative analysis of cost of green-sand cores with cost of dry-sand cores.

Diesel. See DIESEL ENGINES.

Exhaust Gas From. Increase in Output of Engines and Removal of Carbon Monoxide in Exhaust Gas, etc. (Leistungssteigerung der Motoren und Feuerungen und Beseitigung des giftigen Kohlenoxydgases (CO) in den Abgasen insbesondere bei Automobilmotoren), K. Albrecht. Glasers Annalen (Berlin), vol. 106, no. 3, Feb. 1, 1930, pp. 33–35. Discussion of exhaust gases and poisoning of air; removal of carbon monoxide as problem of combustion engineering; operating conditions, carburetors; fuel residues and maximum engine output; analysis of air; properties and generation of air rich in oxygen; engine characteristics when operated with enriched air.

AUTOMOBILE PLANTS

Production Machine Tool for. A Production Machine-Tool of Elastic Design, J. B. Armitage. Soc. Automotive Engrs.—Jl., vol. 26, no. 1, Jan. 1930, pp. 87–88 and (discussion) 89–90, 8 figs. Adaptation of standard machine tool to automobile manufacture as worked out by one milling-machine manufacturer is discussed; beginning with milling machine of relatively simple design, special heads are substituted or added according to requirements of job; adding duplicate head at front makes machine duplex and one or more adjustable heads for vertical spindles can be supported between two main heads.

AUTOMOBILES

Design. Recent Progress in Automobile Design, A. M. Wolf. Soc. Automotive Engrs.—Jl., vol. 26, no. 2, Feb. 1930, pp. 246–249. Critical survey covering advances made during 1929 in various phases of automotive research and design; introduction of front-drive passenger car, performance and acceptance of which are being carefully watched; 8-cylinder engines continue to gain while 12 and 16 cylinders are being experimented with; use of slightly lower ratios; cylinder bores and valve diameter still being increased; new body treatments; refinements of interior.

Front-Wheel Drive. An American Front-End-Drive Car. Sci. Am., vol. 142, no. 1, Jan. 1930, pp. 28–29, 4 figs. Description of Cord front-drive automobile; history of front-drive car in America is mostly racing; closeness with which Cord car hugs ground and yet has road clearance equal to most rear-drive cars.

Fuel. See AUTOMOTIVE FUELS.

Gears, Steel for. Various Steels Are Used for Gears, N. L. Deuble. Iron Age, vol. 125, no. 7, Feb. 13, 1930, pp. 506–508, 1 fig. Discussion is limited to small gears such as used in automotive industry for transmission and differentials; effect of principal alloys; oil-hardened gears are usually chromium steels; case-hardened, nickel steel; heat treatment for rapid production on machine line; typical treatment of chromium steel; question of whether transmission gears are subject to shock; advantages of carburized gears.

Shimmying. Wheel Shimmy Preventive Devised by Use of Friction Springs, F. Meineke. Automotive Industries, vol. 62, no. 6, Feb. 8, 1930, pp. 199–200, 4 figs. Discussion of what is required to prevent shimmying; combination of damping power with restoring force needed to return front wheels to normal position after they are deflected by vibration; steering drag link with friction springs particularly suitable for incorporation in cars already in service; remarkably light spring suffices if spring has proper initial tension and damping.

AUTOMOTIVE FUELS

Detonation. Oxidation in Relation to Engine Detonation, J. C. Pope, F. J. Dykstra, G. Edgar. Engr. (Lond.), vol. 20, no. 263, Jan. 1930, p. 20. Results of investigations made in Research Laboratory of Ethyl Gasoline Corp.; data relates to paraffin hydrocarbons with eight carbon atoms known as octanes; distinct differences exist in regard to behavior of these hydrocarbons when mixed with air and passed through furnace at temperatures ranging between 200 and 700 deg. cent.; with straight-chain hydrocarbon known as normal octane, oxidation proceeds almost entirely according to simple reactions.

Volatility. Motor-Fuel Volatility, G. G. Brown and E. M. Skinner. Indus. and Eng. Chem., vol. 22, no. 3, Mar. 1930, pp. 278–288, 17 figs. Equilibrium volatility is defined as per cent by weight vaporized under equilibrium conditions at specified temperature, pressure, and air-fuel ratio; it has been found impossible to determine accurately partial equilibrium volatility of motor fuels in presence of air in any form of apparatus that has been described; methods which have been previously proposed for estimating equilibrium volatility from A.S.T.M. distillation are shown to be inaccurate, although convenient.

B

BEAMS

Perforated, Stresses in. Effect of a Circular Hole on the Stress Distribution in a Beam under Uniform Bending Moment, Z. Tuzi. Lond., Edinburgh and Dublin Philosophical Mag. and Jl. of Sci. (Lond.), vol. 9, no. 56, Feb. 1930, pp. 210–224, 6 figs. Investigation of stress distribution in beam having hole on neutral axis and subjected to uniform bending moment; experimental results obtained by photoelasticity, using new material, Phenolite, five times more sensitive than Xylonite; stresses are measured directly, counting interference fringes; experimental results compared with theory worked out in this paper.

BEARINGS

Anti-Friction, Fits in. Assembly Fits in Anti-Friction Bearings (Einbaupassungen fuer Waelzlager), T. Damm. Werkstattstechnik (Berlin), vol. 24, no. 2, Jan. 15, 1930, pp. 49–50, 2 figs. International standard conference has come to final conclusion regarding fits for roller bearings; scheme as it stands now only has validity for ball bearings; bore and outside diameter for other types of anti-friction bearings are also given; standards for assembly fits have not been arrived at and under consideration of main factors involved, anthor discusses rules on which assembly standards for roll bearings in general can be based.

Anti-Friction, Pressure Measurements on. Pressure Measurements on Roller Bearings (Druckmessungen an Walzenlagern), O. Von Auwers. Wissenschaftliche Veroeffentlichungen aus dem Siements-Konzern (Berlin), vol. 8, no. 2, July 8, 1929, pp. 137–143, 22 figs. Examples of measurement and possibilities of their practical application; many sidedness of measurements if viewed from economic angle.

Lubrication. Oil Lubricated Journal Bearings (Les coussinets a routement sue huile), H. Brillie and A. M. Robb. Génie Civil (Paris), vol. 95, nos. 24 and 25, Dec. 14, 1929, pp. 586–589 and Dec. 21, 1929, pp. 618–620, 14 figs. Detailed French digest of paper read before Rome meeting of Institute of Naval Architects; so-called "wedge formation" is not essential to maintenance of perfect film lubrication; expression is developed for giving actual thickness of oil film, or clearance between shaft and journal; outline of bearing for turbine machinery.

BELTS AND BELTING

Rubber, Friction Coefficients. Friction Coefficients Between Rubber and Various Materials (Sui coefficient d'attrito fra gomma e vari materiali), R. Ariano. Il Politecnico (Milan), vol. 77, nos. 10 and 11, Oct. 1929, pp. 555–562 and Nov. 1929, pp. 619–628, 14 figs. Results of tests made at Engineering Laboratory of Società Italiana Pirelli; effect of speed of slipping, condition of service, temperature and tension upon friction coefficient of rubber belting; friction coefficients between rubber and wood, rubber and concrete, rubber and iron; results are compared with those obtained at Iowa State College, by T. R. Agg.

BOILERS

Design. Influence of Design of Boiler and Firebox on Slag Formation on Heating Surface (Einfluss der Kesselbauart und Feuerraumform auf das Verschlacken der Heizflaeche). Waerme- und Kaelt-Technik (Muehlhausen), vol. 32, no. 2, Jan. 31, 1930, pp. 6–8, 4 figs. It is shown how, with aid of softening curve of coal ash, it is possible to determine numerically if danger of slag formation exists; advantages of such softening curves for design of boilers and boiler furnaces as compared with usual fusion-point determination is demonstrated.

Furnaces, Design of. Economics of Boiler Furnace Design, J. Y. Parce, Jr. Colo. Engr., vol. 26, no. 2, Jan. 1930, pp. 52–54, 70 and 72, 4 figs. Principal factors which enter into economic study of boiler-furnace problem are discussed; water- and air-cooled wall construction; minimum total surface requirements reached when furnace is about 40 per cent water-cooled;

several different ways of partially cooling furnace; each type of water-cooled furnace designed has some field for which it is particularly advantageous.

Furnaces, Water - Cooled. Furnaces for Powdered Coal—Should They Be Apartmented? R. Mathews. Power Plant Eng., vol. 34, no. 4, Feb. 15, 1930, pp. 218–221, 1 fig. Discussion of boiler efficiency with reference to furnaces with water walls and article advocates more attention to thermodynamics of solid flue combustion; Scotch marine boiler offers same problem as small water-cooled furnaces; experiments must be resorted to in order to obtain necessary information; carbon particles form effective heat screen; forced circulation might be advisable.

High-Pressure, Atmos. Latest Development of the Atmos Boiler (Atmospannans senaste utveckling), J. V. Blomquist. Teknisk Tidskrift (Stockholm), vol. 59, no. 51, Dec. 21, 1929 (Mekanik), pp. 153–161, 11 figs. Experiments and several installations of Atmos boiler are described; characteristic is that it is built of tubes assembled in hub that rotates, thus giving ideal steam generation, making it suitable for very high pressures.

New Atmos Boiler (Der neue Atmoskessel), E. Josse. Archiv. fuer Waermewirtschaft (Berlin), vol. 11, no. 1, Jan. 1930, pp. 5–9, 9 figs. Description of new rotary boiler with squirrel-cage rotor; influence of rotary movement on temperature conditions in steaming tubes; details of boiler installed in plant of Société Alsacienne de Constructions Mécaniques in Muehlhausen, for the generation of 10 to 14 tons of steam per hour at 110 atmospheres pressure and 450 deg. cent.

High Pressure, Benson. Tests on a Benson Boiler, E. Josse. Engineering (Lond.), vol. 49, no. 3340, Jan. 17, 1930, pp. 89–90, 3 figs. Account of tests, made on boiler at Charlottenburg Technische Hochschule; boiler used was installed by Siemens-Schuckertwerke for purposes of test and had output of 6614 lb. of steam per hour, pressure of 3381 lb. per sq. in. and temperature of 842 deg. fahr.

Marine, Pulverized-Coal-Fired. Pulverized Coal for Marine Boilers, E. H. Peabody. World Eng. Congress Part 1—Paper (Tokyo), no. 426, 1929, 23 pp., 10 figs. on supp. plates. Brief discussion of pulverized-coal burning installations; major portion of paper touches on following: tests at Philadelphia Navy Yard; burner design; advantages of pulverized coal; type of pulverizer; screens for classifying pulverized coal; distributors; driers; review of papers on pulverized coal for marine purposes. (In English.)

Plates, Alloy-Steel. Special Steels for Boiler Construction (Sonderstaehle fuer den Kesselbau), M. Ulrich. Archiv fuer Waermewirtschaft (Berlin), vol. 11, no. 1, Jan. 1930, pp. 11–15, 14 figs. Results of tests on special steels whose properties, at reasonable costs, fulfil requirements of boiler plate; aging resistance of Izett steel, was experimentally demonstrated; prolonged tests (up to 2000 hours) at 500 deg. cent. showed that molybdenum steel is greatly superior to carbon steel.

Plates, Temperature Effect. Elastic Limit and Strength at High Temperature of Boiler-Construction Materials (Warm-Streckgrenzen und Warm-Festigkeiten der Kesselbaustoffe), P. Fischer and V. Ehmcke. Kruppsche Monatshefte (Essen), vol. 10, Dec. 1929, pp. 209–211. Tabulation of design constants up to 500 deg. cent. and 212.7 atmos., as indicated.

Priming. Priming of Boilers (Das Mitreissen von Wasser aus dem Dampf-kessel), C. Eberle. V.D.I. Zeit (Berlin), vol. 74, no. 1, Jan. 4, 1930, p. 22. Note on experiments regarding boiler priming at high pressures carried out by C. Eberle at University of Darmstadt; investigations, which have been independent of construction and operating characteristics of boiler, deal with relations between humidity and steaming surface; steam contents, steam output, and other design particulars of boiler.

Pulverized-Coal-Fired. General Operation Experiences With the First Wood Steam Generator, E. W. Smythe. Engineering (Lond.), vol. 129, no. 3342, Jan. 31, 1930, pp. 149–152, 8 figs.; and Engineer (Lond.), vol. 149, nos. 3864, 3865, and 3866, Jan. 31, 1930, pp. 142–144, and (discussion) 127–128, Feb. 7, p. 170 and (discussion 157–158, and Feb. 14, pp. 194–195, 25 figs. Record of actual experience obtained throughout various stages of development and subsequent operation of first radiant-heat boiler in Great Britain, fired exclusively with pulverized fuel, comprising plant known as Wood steam generator. Paper read before Instn. Mech. Engrs., Jan. 24, 1930.

Ladd Boiler at the East River Power Station, New York. Engineer (Lond.), vol. 149, no. 3864, Jan. 31, 1930, p. 141, 6 figs. Particulars and illustrations of boilers erected in station of New York Edison Co.; one boiler has reached enormous evaporation of 1,250,000 lb. per hr.; they are of Double Ladd type, with integral economizers, and furnaces are completely water-walled with fin tubes; powdered coal enters through rows of vertical burners, but beneath each of these there is smaller horizontal burner; designed by the Combustion Engineering Corporation.

Regulators. Automatic Boiler Control in a Combined Steam-Hydroelectric Plant (Automatische Kesselregelung in einem Dampf-Wasser-Kraftwerk), K. d'Huart. Waerme (Berlin), vol. 53, no. 9, Mar. 1, 1930, pp. 134–138, 14 figs. Economic load equalization of boiler sets in combined steam-hydro plants obtained with furnace control regulators; requirements of such regulations; description of Arca regulators and results obtained.

Riveting. Pin Riveting of Steam Boilers (Stiftnieten von Dampfkesseln), A. Hlava. V.D.I. Zeit. (Berlin), vol. 74, no. 4, Jan. 25, 1930, pp. 119–120, 9 figs. Features of special equipment and methods for pin riveting of seams of high-pressure boilers developed at the Skoda plant.

Testing. Test Made on 510-Sq. M. Babcock and Wilcox Boiler at Abo Municipal Power Station (Prov. utforda med Babcock and Wilcox Angpanna vid Abo Stads Elektricitetsverk), G. F. Heikel. Teknisk Tidskrift (Stockholm), vol 60, no. 3, Jan. 18, 1930 (Mekanik), pp. 1–5, 4 figs. Test on boiler equipped with superheater, chain stoker, and economizer gave, with output of 7 to 27 tons steam per hour, efficiency factor of 85 to 88 per cent; idling consumption was 73 kg. coal per hr.

Tubes, Ribbed. Ribbed-Tubes Boiler (Rippenrohrkessel), K. d'Huart. Waerme (Berlin), vol. 53, no. 8, Feb. 22, 1930, pp. 113–116, 9 figs. Description of Rauber and Luquet ribbed-tube boiler; and fire-tube boiler of Wehrle Machine Works.

BROACHING MACHINES

German. Development, Design Features and Capacity of Modern Broaching Machine (Entwicklungsgang, Konstruktionsmerkmale und Leistungen einer modernen Raeummaschine), A. Helbig. Maschinenbau (Berlin), vol. 9, no. 2, Jan. 16, 1930, pp. 41–47, 23 figs. Equipment of Dolze and Slotta, Coswig, type DSN is described; principles underlying design; development of spindle drive from rack drive; holding device; choice of three cutting speeds; operating range and drilling capacity of four sizes which are manufactured in series are explained on basis of curves and tables.

BRONZE

Castings. Effects of Oxidation and Certain Impurities in Bronze, J. W. Bolton and S. A. Weigand. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 281, for mtg. Feb. 1930, 17 pp., 36 figs. Paper discusses some fundamental metallurgical principles involved in production of sound cast bronze, and supplements previous paper in which theory was advanced that oxidation in bronze casting is due to incipient shrinkage; effects of certain impurities and of actual oxidizing conditions are shown; appendix deals with appearance of various inclusions. Bibliography.

C

CABLEWAYS

Rope Sag. Practical Permissible Sag in Wire Rope for Cableways and Cable Cranes (Ueber die praktische Ermittlung der Seildurchhaenge bei Seilbahnen und Kabelkranen), V. Bradel. Foerdertechnik und Frachtverkehr (Wittenberg), vol. 23, nos. 3 and 4, Jan. 31, 1930, pp. 43–47 and Feb. 14, pp. 68–73, 13 figs. Jan. 31: Simple, practical equation for calculating sag with approximate accuracy is derived; discussion of errors and assertions in exact method. Feb. 14: Influence of friction; movement of stretching weight of rope; correction of calculation of sag in French passenger cableway.

CHEMICAL ENGINEERING

Progress in 1929. Chemical Engineering Progress in 1929, J. W. Hinchley. Indus. Chemist (Lond.), vol. 6, no. 51, Feb. 1930, pp. 53–56. Attitude of manufacturer toward chemical research; need for chemical engineering research; improvements in fuel economy; importance of materials of construction such as iron and steel alloys; progress in utilization of iron-nickel-chromium alloys; bearing properties of stainless steel; nitrogen method of hardening steel; use of nickel alloys; metals coatings; chemical plant equipment.

CHROMIUM-NICKEL STEEL

Drawing. Drawing Chrome-Nickel Alloy Utensils. Iron Age, vol. 125, no. 6, Feb. 6, 1930, pp. 445–446, 1 fig. Allegheny metal used for hotel, household and hospital ware requires high heat treatment and special care in processing methods employed by Lalance and Grosjean and Grosjean Mfg. Co., Woodhaven, N. Y.; white pickled instead of polished sheets; heat treated at 1900 to 1950 deg.; finished by grinding four times; welding to be used in making attachments.

COAL

Carbonization, Low-Temperature. Low-Temperature Carbonization, D. Brownlie. Chem. and Industry (Lond.), vol. 49, no. 5, Jan. 31, 1930, pp. 92–94, 2 figs. Account of modern work on commercial scale with Babcock process; arrangement consists of overhead coal bunker, predrier, retort, and screw-conveyor feed gear to chain-grate stokers, while coal in passing down through retort is carbonized at about 1290 deg. fahr. by mixture of superheated steam and combustion gases.

Handling. See MATERIALS HANDLING

COMBUSTION

Furnace. Calorific Value, Heat Balance, and Efficiency in Furnace Technique (Heizwert, Waermebilanz und Wikungsgrad in der Feuerungstechnik), K. Rummel and G. Neumann. Archiv. fuer das Eisenhuettenwesen (Duesseldorf) vol. 3, no. 8, Feb. 1930, pp. 531–544, 1 fig. Relations between chemical energy and calorific value for wet and dry fuels (solid, liquid, and gaseous); balances with upper and lower calorific value; advantages and disadvantages of upper and lower values.

Submerged, Equipment for. Submerged Combustion. Iron and Coal Trades Rev. (Lond.), vol. 120, no. 3233, Feb. 14, 1930, pp. 273–274, 4 figs. History and development of submerged combustion; principles involved; submerged combustion is method of heating by direct contact of flame from burner which projects white-hot gases of flame directly into and at any depth below surface of fluid or liquid substance such as water, oil, tar or substances which are solid at normal temperature but which may be rendered liquid by application of heat, such as paraffin wax, pitch, lead, tin, zinc, and other white metals. Abstract of paper read before Inst. of Fuels.

CONTAINERS

Railway Shipments. Latest Patents for Containers for Railroad Transportation (Neuere Patente betreffend den Behaelterverkehr auf Eisenbahnen), Walther. Foerdertechnik und Frachtverkehr (Wittenberg), vol. 23, no. 4, Feb. 14, 1930, pp. 65–68, 10 figs. Discussion of container for railroad shipment; adapting containers to all kinds of packing requirements from vans and trucks to smaller containers mounted on casters; examples of loading containers on railroad cars.

CONVEYORS

Box. A Conveyor System That Handles Three Million Boxes a Year, T. A. Keefer. Machy. (N. Y.), vol. 36, no. 6, Feb. 1930, pp. 437–441, 8 figs. Discussion of conveyor system employed in plant of National Cash Register Co., Dayton, Ohio, of which over eight miles are in use; installation served six buildings containing over 100,000,000 sq. ft. or 24 acres of floor space; vertical conveyors extend from basements to top floors; how boxes are dispatched and received; conveyor spirals permit temporary storing of boxes.

COPPER ALLOYS

Copper-Magnesium. Constitution of Magnesium-Copper Alloys, J. A. Gann and A. W. Winston. Am. Soc. for Steel Treating—Trans., vol. 17, no. 2, Feb. 1930, pp. 292–293, 1 fig. Article gives equilibrium diagram and results of investigation of crystal structure and X-ray examination. Recommended Practice Committee release.

Welding. Welding Facts and Figures, D. Richardson and E. W. Birch. Welding Jl. (Lond.), vol. 26, no. 315, Dec. 1929, pp. 386–388. Properties of copper and nickel alloys are discussed; high copper alloys have excellent welding characteristics combined with good strength; analysis of nickel alloys and methods of welding taken up.

COST ACCOUNTING

[See INDUSTRIAL MANAGEMENT.]

CRANES

Aluminum Traveling. Traveling Crane Is Built of Aluminum, F. V. Hartman and E. C. Hartmann. Iron Trade Rev., vol. 86, no. 6, Feb. 6, 1930, pp. 82–83, 2 figs. Description of 10-

ton traveling crane recently installed in works of United States Aluminum Co., Massena, N. Y., which is three-motor single-hook machine with lift of 22 ft.; aluminum-alloy shapes used in construction of cranes; special care used in riveting members to avoid excessive temperatures; machine tested under 34,500-lb. load or 72 per cent above rating; no fabricating difficulties encountered.

Variable-Radius. Economy of Cranes With Variable Radius and Horizontal Track (Die Wirtschaftlichkeit von Einziehkranen mit wagerechter Lastbahn), Ruediger. Foerdertechnik und Frachtverkehr (Wittenberg), vol. 23, no. 1, Jan. 3, 1930, pp. 6–13, 3 figs. Discussion of cranes with variable radius; investigation of actual importance of economical advantages which are expected by using horizontal track; saving on power; reduction of loading and time; disadvantage from adjustment in loading moment; limit of economy.

CUTTING TOOLS

Standardization. Production Division. Soc. Automotive Engrs.—Jl. Reports of Divisions to Standards Committee (Section 2), Jan. 1930, pp. 30–49, 30 figs. Proposed American standard for milling cutters; nomenclature; definitions of milling cutters; proposed revision and extension of S.A.E. standard for woodruff key-slot cutters and gages; proposed revision of S.A.E. recommended practice for plug and ring gages: proposed American standard and revision of S.A.E. standard for cut and ground threads for taps; line cuts and dimensions given for different types of milling cutters, keyways, and gages.

Testing. Laboratory Tests Aid Tool Development, C. O. Herb. Machy. (N. Y.), vol. 36, no. 6, Feb. 1930, pp. 425–429, 9 figs. Description of physical testing and chemical laboratories of Morse Twist Drill and Machine Co., Bedford, Mass., for investigating proposed designs of tools; determining properties of raw materials; raw materials and tools checked for various properties in torsion-testing machines; determining cutting capacity of tools; drill endurance tests; other equipment of physical testing laboratory.

Comparison Between Practical and Laboratory Tests on Tools of Hardened Steel (Jamforelse mellan praktiska prov och laboratorie-prov. pa verktyg av hardat stal), A. Lundgren. Statens Provningsanstalt (Stockholm), no. 45/46, 1929, pp. 10–24, 7 figs. Report of results obtained from testing veneer knives, tobacco knives, teeth for milling cutters for working on steel, taps for working on cast iron and dies for working on steel; different kinds of steel and heat-treatment methods have been used; comparative tests show certain agreement for certain groups as regard practical utility.

Tungsten Carbide. Fixed Method Preferred to Free Hand Operations in Grinding Cemented Tungsten Carbide Tools, H. W. Wagner. Automotive Industries, vol. 62, no. 9, Mar. 1, 1930, pp. 370–373, 5 figs. As material to be ground is very valuable, wheel cost is of less importance than when high-speed steel is shaped; successful methods include compromises in grade, special devices and feeding skill; grinding resistance; General Electric Co. using grinding machines with spring pressure between wheel and work; remedies suggested for grinding; pressure and feed; wet grinding; lapping and honing.

Tungsten Carbide and Casting, A. K. Brumbaugh. Soc. Automotive Engrs.—Jl., vol. 26, no. 2, Feb. 1930, pp. 140–142. Description of experience of White Motor Co. with Carboloy tools; special knowledge necessary to realize its best advantages; sharpening tools and cutting sharp corners; how tools should be ground.

Uses of Cemented Tungsten Carbide Extend Beyond Expectations, J. Geschelin. Automotive Industries, vol. 62, no. 7, Feb. 15, 1930, pp. 227–228, 2 figs. Widespread adoption of this new tungsten-carbide tool material was attended by some grief resulting from lack of standardization and limited knowledge of its limitations; recognition of factors involved in tooling practice for production results in manufacturing economies; mounting of cemented tungsten carbide tool tips is vital factor in life of tool; necessity for maintaining tool form when regrinding.

CYLINDERS

Stresses in. Approximate Theory of Cylindrical Shell (Théorie approchée de l'enveloppe cylindrique épaisse). Génie Civil (Paris), vol. 95, no. 23, Dec. 7, 1929, pp. 566–568, 5 figs. Author proposes original mathematical analysis of stresses in cylindrical shells which approximate results of analysis based on theory of elasticity; application of this theory to case of non-cylindrical shells and shells made of reinforced concrete, also to cast-iron and concrete linings of mine shafts.

D

DIESEL-ELECTRIC POWER PLANTS

Great Britain. Supercharged Diesel Generator at Ashford. Gas and Oil Power (Lond.), vol. 25, no. 292, Jan. 2, 1930, pp. 61–62, 1 fig. Description of 1350-hp. eight-cylinder Davey Paxman oil engine set, for normal load of 600 kw., but capable of developing 900 kw. when supercharged; engine, which has English-Electric single bearing alternator, is claimed to be first of its type installed in any electric station in Great Britain; supercharger was constructed by British Brown-Boveri, Ltd.

DIESEL ENGINES

Automotive. Fuel Injection With By-Pass Valve Control for Diesel Engines Developed by Linke-Hofmann-Busch, E. P. A. Heinze Automotive Industries, vol. 62, no. 10, Mar. 8, 1930, pp. 398–400, 6 figs. Description of line of five 4-cycle Diesel engines for automotive and marine work as well as for stationary purposes, which have been introduced by Linke-Hofmann-Busch works, Breslau, Germany; compression chamber is of unusually compact design; combustion space is formed by small lateral pocket cast in cylinder head; smallest engine has four cylinders and develops 50 to 60 hp. at 1200 to 1500 r.p.m.; 6-cylinder 90-hp. engine intended specially for trucks, buses, and tractors.

Fuel Injection in. Injection Lags in a Common-Rail Fuel Injection System, A. M. Rothrock. Nat. Advisory Committee for Aeronautics—Tech. Notes, no. 332, Feb. 1930, 7 pp., 7 figs. Injection lags determined for common-rail fuel-injection system for compression-ignition engine; system consisted of high-pressure reservoir, timing valve, injection valve tube and automatic injection valve; lag increased linearly with increase in injection-tube length, but was not affected by bore of tube; lag increased slightly with increase in valve opening pressure, and decreased materially with increase in injection pressure.

Great Britain. British Compressorless Diesel Engines (Englische Kompressorlose Dieselmotoren), H. Mehlig. V.D.I. Zeit. (Berlin), vol. 74, no. 6, Feb. 8, 1930, pp. 171–172, 8 figs. Short note on engines of Crossley Brothers; Blackstone Co.; Davey, Paxman and Co.; Gleniffer Motors, Ltd.; Beardmore and Co., some details of design are given.

Sleeve-Valve. High-Speed Stationary Sleeve-Valve Engine, Ricardo System (Moteur fixe à grande vitesse, sans soupapes, système Ricardo). Génie Civil (Paris), vol. 96, no. 2, Jan. 11, 1930, pp. 42–43, 2 figs. Diesel engine developed by Peter Brotherhood of Petersborough, England, showing modern design; trends of increased speed at low cost; little space requirements and facilities for easy direct coupling to electric generators is described; machines are made in four standard types of 2, 3, 4, and 6 cylinders, each developing 50 b.hp. at 900 r.p.m.

DRILLING MACHINES

Heads, Design of. Designing Multiple-Spindle Drilling Heads, A. M. Wasbauer. Machy. (N. Y.), vol. 36, no. 6, Feb. 1930, pp. 475–476 and 2 supp. sheets 171 and 172. Application of data sheets to solutions of problems involved in designing drilling heads equipped with drills of various sizes which must all feed at same rate; chart is given which has scale showing number of cubic inches of metal removed per minute by drills ranging from 1/8 to 1 3/8 in. in diam. operated at feeds of from 1 to 12 in. per min.

Speed Standardization. Applicability of the VDW Standard Rules for Speed Changers in Drives of Machine Tools Used in Manufacture of Drilling Machines (Die Anwendbarket der VDW-Richtlinien fuer die Stufenspruenge der Getriebe von Werkzeugmaschinen bei dem Bohrmaschinenbau), R. Panzer. Werkstattstechnik (Berlin), vol. 23, Dec. 1, 1929, pp. 661–666, 5 figs. 157 drilling machines of German, English, and American manufacture have been investigated and it is found that all speed changers come within limits of third VDW specification and that limits are enough; one example to determine total transmission ratio is given.

E

ECONOMIZERS

Recent Developments in. The Economizer—Some Recent Developments, With Experimental Data and Conclusions, G. E. Tansley and O. Kubalek. S. Wales Inst. of Engrs.—Proc. (Cardiff, Wales), vol. 45, no. 6, Feb. 11, 1930, pp. 480–512 and (discussion) 512–519, 12 figs. Paper deals with some of more recent aspects of heat recovery from so-called waste gases, fuel economizer being taken as best known and most widely used appliances for this purpose; results on tests of economizers; discussion of various types of economizer surface; description of gilled-tube economizer; examples of calculation of saving effected by use of economizer.

ELECTRIC FURNACES

Germany. Electric Furnaces (Ueber Elektro-Oefen), V.D.I. Belani. Montanistische Rundschau (Berlin), vol. 21, no. 24, Dec. 16, 1929, pp. 479–483, 4 figs. Various types of furnaces built by Siemens and Halske A. G. are enumerated; uses to which they may be put and their special features; arc furnaces are used for production of sponge iron, of high-quality alloy steels, and of high-quality cast iron (in conjunction with cupola), for melting scrap, and for refining (in duplex process with open-hearth furnace or bessemer converter).

Heat-Treating. Electric Heat and Heat-Treating Alloy Steel, T. W. Hardy. Heat Treating and Forging, vol. 16, no. 1, Jan. 1930, pp. 53–58, 9 figs. Advantages gained by application of electric energy to heating more than outweigh costs; efficiency of heat transfer and improvement in quality are important; cost of annealing and heat treating including labor, maintenance, power or fuel, investment and retreatment of defective work; short- and long-cycle annealing; normalizing; heat treatment of bars; annealing of rods or wire in coils.

Steel-Making. A modern Electric Steel Plant (Ein neuzeltliches Elektro-Stahlwerk), K. Kerpely. Giesserei-Zeitung (Berlin), vol. 27, no. 4, Feb. 15, 1930, pp. 101–102, 4 figs. Description of new plant in Campia Turzii, Roumania, for production of iron and steel wire and wire products of all kinds; reasons are given for installing electric furnace, which is 3-phase arc type with capacity of 1 to 1.5 tons, equipped with 500-kva. 3-phase oil transformer with automatic hydraulic electrode regulation of Brown-Boveri system.

ELECTRIC POWER SUPPLY

Berlin. Past and Future Developments of Power-Supply System of BEWAG (Entwicklung der Strombersorgung der BEWAG in Vergangenheit Gebenwart und Zukunft), M. Rehmer and E. Krohne. Elektrizitaetswirtschaft (Berlin), vol. 29, nos. 499 and 500, Jan. 1, 1930, pp. 1–7 and Jan. 2, 1930, pp. 36–39, 15 figs. Review and historical development up to 1929; future developments are to be simplification of 30-kv. distribution network and of 100-kv. loop line; it is contemplated to introduce distribution system applying two voltages for districts of high-load density and one with three voltages and small transformer stations for low-load density sections; comparison with some American systems.

F

FANS

Testing. Tests of Disc. and Propeller Fans, A. I. Brown. Heat. Piping and Air Conditioning, vol. 2, no. 2, Feb. 1930, pp. 157–163, 1 fig. Purposes of paper are to discuss testing disk and propeller fans, and presentation of typical data and performance curves for fans of airplane propeller type; fan ratings; power required by perfect fan; methods of testing; table of fan capacities for airplane propeller type and thin pressed metal blades; comparison of ratings by different test methods; reliability of standard code method of testing; measurements of low velocities by orifice meter; discussion of table of results. Presented before Am. Soc. Heat. and Vent. Engrs.

FEEDWATER TREATMENT

Softening. Some Notes on Water Softening, J. Gordon. Gas World (Lond.), vol. 92, no. 2370, Jan. 4, 1930, pp. 10–13 (Coking section), 1 fig. Power plant at Lambton consists of six Lancashire boilers, each 30 ft. long by 8 ft. in diameter; four are heated by gas and waste heat from ovens and two are hand-fired; total evaporation of water per day is about 50,000 gal.; boiler water tests; softening inside boiler; chemistry of softening by caustic soda; lime and soda ash treatment; amount of sludge and of evaporation. Paper read before Coke Oven Managers' Assn.

Water Softening Practice in Great Britain, D. Brownlie. Combustion, vol. 1, no. 7, Jan. 1930, pp. 39–44, 10 figs. Description of improved types of reagent feed gear and combined lime and soda ash and base-exchange treatment, chief features for boiler feedwater; description of typical installation and four systems that are used most intensively.

FLIGHT

[See GLIDING.]

FLOW OF FLUIDS

Measurement. Discharge Coefficients of Nozzles and Pipe Diaphragms (Durchflusszahlen von Duesen und Stauraendern), R. White. V.D.I. Zeit. (Berlin), vol. 74, no. 2, Jan. 11, 1930, pp. 47–50, 8 figs. Report on new tests of I. G. nozzles and pipe diaphragms discharging water, steam, or gases; testing principle of similitude; conditions of undisturbed flow; effect of diameter on discharge coefficient; gas discharge coefficients; features of new apparatus independent of viscosity. Abstract of paper published in Technische Mechanik und Thermodynamik, vol. 1 (1930), no. 1, p. 34.

FLOW OF GASES

Natural-Gas Pipe Lines. Detemination of Friction Coefficient of Long-Distance Gas Pipe Lines (Zur bestimmung der Reibungszahl in Ferngasleitungen), E. Guman. V.D.I. Zeit. (Berlin), vol. 74, no. 4, Jan. 25, 1930, pp. 107–110, 3 figs. Theory of flow of gas through pipe lines; results of six months observations and measurements on flow of natural gas through 48 km. of 25.3 cm. pipe line between Sarmas and Turda, in Roumania; measurements indicate variation of friction coefficient with Reynolds' number.

FORGINGS

Heat Treatment. Heat Treating in a Modern Forge Shop, M. J. Gorman. Heat Treating and Forging, vol. 16, no. 1, Jan. 1930, pp. 41–42, 3 figs. Description of heat-treatment equipment of Moore Drop Forging Co., which consists of four continuous ranging in sizes from 13 to 21 ft. long and 6 ft. wide; handling quenching mediums; typical results of heat treatment; hardening forging and header dies.

FURNACES

Metallurgical. The Application of Pulverized Fuel to the Malleable Iron Foundry. Iron and Steel Industry (Lond.), vol. 3, no. 4, Jan. 1930, pp. 120–121 and 128, 2 figs. Use of pulverized coal in melting furnaces for production of malleable cast iron, and savings obtained discussed; advantages of using pulverized coal in annealing furnaces.

Normalizing. Recent Developments in Normalizing Sheet Steel, E. S. Lawrence. Fuels and Furnace, vol. 8, no. 2, Feb. 1930, pp. 191–194. Discussion of major mechanical, mechanical-metallurgical, and metallurigcal improvements of continuous sheet-normalizing furnace; correctly constructed cooling chamber wherein time and rate of cooling sheets are emphasized. Abstract of Paper presented before Am. Soc. Steel Treating.

FOUNDRIES

Research in. Research in the Foundry, E. E. Griest. Am. Foundrymen's Assn.—Trans. and Bul., vol. 1, no. 1, Jan. 1930, pp. 79–86. Improvements in foundry are due to ever-careful analysis of many details involved in production of castings; present methods can be bettered by diligent protracted investigations; shop workers can be true researchers; good castings up to individual foundries; specially trained men replace skilled molders; increasing production by analyzing core methods; sales department should do its part; valuable improvements by equipment makers; what safety research can accomplish.

G

GAGES

Electric. Electric Precision Gage of Great Accuracy. Machy. (N. Y.), vol. 36, no. 6, Feb. 1930, pp. 435–436, 3 figs. Description of electric gage designed to meet demand for accurate gaging device that has minimum of moving parts and that will permit routine gaging operations to be conducted with greater rapidity; with amplification factor of 10,000, this gage, independent of human touch, makes possible measurements to 0.00005 in.; gage may be used for both inside and outside measuring.

The Electric Gauge, A. V. Mershon, J. W. Matthews and B. C. Waite, Jr. West. Machy. World, vol. 21, no. 1, Jan. 1930, pp. 10 and 30, 3 figs. Description of electric gage developed to meet demands for accurate gaging device for quantity inspection purposes; gage is independent of human sense of touch; simple and rapid to manipulate; amplification factor 10,000 times.

Optical. Optics in Measuring Technique (Die Optik in der Messtechnik), Berndt. Deutsche Optische Wochenschrift (Weimar), vol. 16, no. 1, Jan. 5, 1930, pp. 2–4, 15 figs. Description of instrument for gaging machine tools, drills, screw threads, gear teeth, etc.

Optical Measuring Machines. Engineering (Lond.), vol. 129, no. 3344, Feb. 14, 1930, pp. 236–237, 11 figs. Measuring machine made by C. Zeiss, of Jena, dispenses with use of micrometer screws and gage blocks, which are subject to slow molecular changes, and of hydraulic feelers, which must exert some pressure, and is based upon comparator principle; optical system of optimeter is explained by diagram.

GLIDING

Sailplaning. Sailplaning, H. Hartshell. Aero Digest, vol. 16, no. 1, Jan. 1930, pp. 113–115, 3 figs. Prediction of how sailplaning may be practiced in future and principles in which sailplane may be flown; monoplane glider is chosen with high aspect ratio and safely controllable flying speed as low as 20 to 25 m.p.h.; velocities acting on sailplane are calculated; forces and velocities projected in transverse vertical plane; no glider built like airplane can soar effectively.

H

HAMMERS

Pneumatic. Investigations of Compressed-Air Hammers (Untersuchung von Presslufthaemmern), G. Schlesinger, and F. Haensel. Werkstattstechnik (Berlin), vol. 24, nos. 1 and 3, Jan. 1, 1930, pp. 1–9 and Feb. 1, 1930, pp. 60–66, 14 figs. Operating characteristics, number, life, speed, powder, time involved, and air consumption in forward and backward motion in working of various materials; experiments pertain to riveting and chiseling hammers; results of tests are given in curves and tables.

HARDNESS TESTING

Brinell. Brinell Indentations With Differen Testing Loads (Brinelleindruecke bei versehiedener Prueflast), P. W. Doehmer. Zeit. fuer Metallkunde (Berlin), vol. 22, no. 1, Jan. 1930, pp. 31–32, 3 figs. Author claims that for practical testing purposes, conversion of ball-impression diameters obtained with specific load into diameters obtained with other loads is not possible without knowledge of N-value of material; it is simpler to actually measure desired ball impression with other testing loads instead of calculating it; some results of practical calculations are listed.

HEAT CONDUCTIVITY

Measurement. Measurement of Heat Conductivity by Suitable Variation of Kohlrausch Method for High Temperatures (Waermeleitfaehigkeitsmessung nach einer fuer hohe Temperaturen geeigneten Variation der Kohlrauschschen Methode), R. Holm. Zeit. fuer Technische Physik (Leipzig), vol. 10, no. 12, 1929, pp. 621–623, 2 figs. Description of method, measurements on platinum and control test on Holm's contact theory.

HEAT-INSULATING MATERIALS

Properties of. Heat Insulators, E. Griffiths. Dept. of Scientific and Indus. Research—Food Investigation (Lond.), no. 35, 1929, 96 pp., 37 figs. Definition of thermal conductivity; design of apparatus for conductivity tests; temperature measurements; typical example of thermal conductivity experiment; convection currents in granular materials; description of materials tested, and values of their thermal conductivity; moisture absorbing capacity of insulating materials; temperature of combustion of various insulators; calculation of heat flow in complex structures; determination of specific heats of insulating materials.

HEAT TRANSMISSION

Parallel Plates to Flowing Air. Heat Transfer to Air Between Two Plane Parallel Plates in Eddy Current (Der Waermeuebergang an Luft zwischen zwei ebenen parallelen Platten bei Wirbelstroemung), W. Haucke. Archiv. fuer Waermewirtschaft (Duesseldorf), vol. 11, no. 2, Feb. 1930, pp. 53–58, 7 figs. Experimental study of heat transfer of two parallel plates 48 mm. apart to air current flowing between them; evaluation of results.

HEAT TREATMENT

Economics of. Economics and Economies of Heat-Treating, R. M. Keeney. Am. Mach., vol. 72, no. 5, Jan. 30, 1930, pp. 225–227, 3 figs. Selection of source of heat for industrial heat-treatment of metals discussed; items influencing overall cost; various applications of annealing furnaces in Connecticut; fuels for annealing brass; measureable progress has been made in atmospheric control of electric furnaces for bright-annealing copper; for annealing nickel-silver stampings, electric furnaces increasingly used. Abstract of paper read before Am. Soc. Steel Treating.

HELICOPTERS

Propellers. General Study of Lifting Propellers (Studio gener le dell' elica sostentativa), G. Serragli. Notiziario Tecnico di Aeronautica (Rome), vol. 8, no. 12, Dec. 1929, pp. 17–33, 8 figs. Mathematical theory of lifting propellers; formulas for determining shape of ideal lifting propeller; structural economy of helicopters and effect of diameter of propeller on useful load of helicopter; analysis leads author to believe that propeller of high angle of incidence may solve problem of vertical take-off.

HOISTS

Electric, for Freight Cars. Special Safety Devices Built Into Electric Freight Car Hoist. Iron Trade Rev., vol. 86, no. 3, Jan. 16, 1930, pp. 44–45, 1 fig. Description of 200-ton freight car hoist recently erected for new power station of Dusquesne Light Co., Pittsburgh; complete machinery and all auxiliary apparatus enclosed in structural steel shaft tower of guide type erected at end of elevated railroad siding; gates, counterweights and hydraulic buffers provided on 50-ft. hoist with capacity of 400,000 lb.

HYDRAULIC LABORATORIES

Germany. Walchensee Hydraulic Laboratory (Die Wasserbau-Versuchsanlagen am Walchensee), O. Kirschmer. V.D.I. Zeit. (Berlin), vol. 74, no. 2, Jan. 11, 1930, pp. 51–53, 8 figs. Description of new German Hydraulic Research Institute initiated by O. von Miller and managed by Forschungsinstitut fuer Wasserbau und Wasserkraft; station is equipped with earth and concrete lined canals 100 m. to 350 m. in length, having carrying capacities from 4 to 8 cu m. per sec., also calibrating tank having capacity of 1500 cu. m.; stations program of large scale tests.

HYDRAULIC TURBINES

Draft Tubes. Diffusors of Modern Hydraulic Turbines (I moderni diffusori nelle turbine idrauliche), G. Buechi Energia Elettrica (Milan), vol. 6, no. 12, Dec. 1929, pp. 1201–1210, 32 figs. Outline of Prasil theory of draft tubes; theory and features of conical draft tubes, circular diffusors, Kaplan curved axis diffusor, White and Moody hydraucone regainer; Voith, Escher Wyss curved and partitioned draft tubes, etc.

Propeller. On the Hydraulic Efficiency of Propeller Turbines and Propeller Pumps. F., Numachi. Soc. of Mech. Engrs.—Jl. (Tokyo) vol. 32, no. 152, Dec. 1929, pp. 483–493, 15 figs. Paper deals with theoretical study of variations of hydraulic efficiency of propeller turbine and of propeller pump with respect to following coefficients: peripheral velocity of rotation; axial velocity of flow, and ratio of outer diameter to inner diameter of wheel; graphical representations of results service to give information to select suitable values of coefficients. (In English.)

HYDROELECTRIC POWER PLANTS

Ice Control. Forming of Troublesome Ice Prevented by Jets of Compressed Air, J. S. Meehan. Compressed Air Mag., vol. 35, no. 3, Mar. 1930, pp. 3045–3049, 13 figs. Description of equipment and practice at Station No. 1, of Turner Falls Power & Electric Co. on Connecticut River, in township of Montague, Mass.; line $1^1/_4$ in. pipe hung on wall of canal at depth of of 12 ft.; brass plugs with $^1/_{64}$ in. holes at 3 ft. intervals deliver air bubbles at average pressure of 10 lb., preventing formation of shell ice; other parts of intake system were protected in similar manner.

I

ICE

Heat Conductivity of. Thermal Conductivity of Ice Between 0 and 125 Deg. (Die Waermeleitfaehigkeit von Eis zwischen 0 and 125 deg.), M. Jakob and S. Erk. Zeit. fuer die gesamte Kaelte-Industrie (Berlin), vol. 36, no. 12, Dec. 1929, pp. 229–234, 5 figs. Report from experiments made to determine conductivity of ice; thermoelements were frozen in cakes of ice and constants computed from readings; table of constants obtained and description of apparatus used.

IMPACT TESTING

Notched-Bar. Stresses in Fatigue Impact Testing (Zur Frage der Beanspruchung beim Dauerschlagversuch), A. Thum and S. Berg. V.D.I. Zeit. (Berlin), vol. 74, no. 7, Feb. 15, 1930, pp. 200–204, 12 figs. Condensed report on experimental study made at Darmstadt Insti-

tute of Technology; effect of elastic hysteresis and notching on magnitude of stresses caused by impact, with special reference to maximum stresses; lines of force at abrupt changes in cross-sections of specimens; diagrams of distribution of stress intensities at notches; photographs of fractures. Full report published in Bul. No. 331. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens.

INDUSTRIAL MANAGEMENT

Cost Accounting. Influence of Cost of Preparation on Manufacturing Costs of Product (Der Einfluss der Kosten fuer die Arbeitsvorbereitung auf die Herstelkosten des Erzeugnisses), C. Buchholz. Werkstattstechnik (Berlin), vol. 24, no. 1, Jan. 1930, pp. 9–11. Distribution of costs in preparation for continuous production in machinery manufacture is usually done without consideration of extent or number of workpieces involved; when this number fluctuates strongly errors in calculation of production cost results; method for better approach of actual conditions is developed.

Plant Management on Basis of Cost Control, G. A. Prochazka, Jr. Chem. and Met. Eng., vol. 37, no. 2, Feb. 1930, pp. 85–87. Investigation of application of process cost element; study of departmental organization; knowledge of cost of running each department is important phase of cost control; summary of major steps in control of process cost.

Simplifying Overhead Costs in a Small Factory, R. B. Hobson. Mech. World (Manchester), vol. 87, no. 2249, Feb. 7, 1930, pp. 124–125, 1 fig. Method of calculating overhead expenses in small factory is outlined.

Variability of Overhead Costs, D. D. Kennedy. Jl. of Accountancy vol. 49, no. 3, Mar. 1930, pp. 202–212. Definition of overhead costs; analysis of variability in costs; determination of nature of burden accounts; use of coefficient of correlation; testing burden account classification.

Exception vs. Systematic. Management by Exception, C. B. Lord. Am. Mach., vol. 72, no. 7, Feb. 13, 1930, pp. 308–309, 2 figs. Contrast of exception management with systematic management; systematic management assumes theoretical conditions and seeks to control exceptions by making those conditions paramount; exception management makes system subordinate to exception, and, must visualize actual conditions in order to function; four rules governing exception management.

Production Control. The Economics of Production, D. S. Kimball. Soc. Automotive Engrs.—Jl., vol. 26, no. 2, Feb. 1930, pp. 126–128. Discussion of some fundamentals in production costs; some very definite mathematical developments are coming into field of production management; in short time all wise men will be scheduling their material by formula. Abstract.

INDUSTRIAL PLANTS

Purchased vs. Generated Power. A Discussion Comparing Costs of Byproduct and Purchased Power, A. L. Rogers. Power, vol. 71, no. 7, Feb. 18, 1930, pp. 253–255, 4 figs. Comparative cost data is given for two industrial plants, one in which process steam is used for power generation and for mill purposes and other in which management purchases electric power, but all steam required for manufacturing purposes is generated in low-pressure boiler plant.

INTERNAL-COMBUSTION ENGINES

Efficiency. Energy Charts for the Calculation of Standard Efficiencies of Internal Combustion Engines, W. J. Goudie. Instn. of Engrs. and Shipbldrs. in Scotland, vol. 72, 1928–1929, pp. 440–485 and (discussion) 485–495, 14 figs. Energy chart described in this paper is attempt to provide graphical substitute for involved calculation, by means of which absolute thermal efficiency of any internal-combustion engine can be obtained to close degree of approximation by simple process of projection; it takes account fully of effect, on ideal efficiency of fuel composition, air-fuel ratio, variation of specific heat.

Problems. Problems of Internal-Combustion Engine (Probleme des Verbrennungs-motors), L. Richter. Zeit. fuer Technisches Physik (Leipzig), vol. 10, no. 11, 1929, pp. 573–579, 5 figs. Theory and practice; ignition and combustion; two- and four-cycle engines; exchange of mixture and heat transmission; cycle processes; combustion; mechanical and thermal problems of power-engine design. Bibliography.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES.]

IRON AND STEEL PLANTS

Germany. Blast Furnaces and Metallurgical Work of Essen-Borbeck (Hochofen- und Huettenwerk Essen-Borbeck). V.D.I. Zeit. (Berlin), vol. 74, no. 2, Jan. 11, 1930, pp. 33–43, 17 figs. Description of Krupp iron and steel plant having two blast furnaces; 70 to 80 per cent of ore arrive by water; details of river harbor and railroad ore-handling equipment; blast furnaces having useful capacity of 660 cu. m.; charging equipment and steam-electric power plant equipped with two 14,000-kw. turbo-generators.

Inland Steel Company. Inland—A Midwestern Steel Company, C. Longenecker. Blast Furnace and Steel Plant, vol. 18, no. 1, Jan. 1930, pp. 153–173, 27 figs. Description of plants of Inland Steel Co., including Indiana Harbor, Chicago Heights and Milwaukee plants, ore resources and distribution; coal supply; blast furnaces; coke ovens; by-product recovery; open-hearth department; open hearths Nos. 1 and 2 open hearth; 40-in. booming mill; 14 and 10-in. merchant mills; 36-in. blooming mill; 24-in. billet mill; 19-in. bar mill; 24-in. reversing bar mill; 8-in. and 11-in. Morgan mill; plate mill; sheet mill; bolt and rivet department; machine shop; boiler shop; smith shop; power generation.

Sweden. Sandvik, One of the World's Foremost Makers of Fine Steel. Swedish Export (Stockholm), vol. 14, no. 1, Jan. 1930, pp. 4–6, 3 figs. Description of steel works in Sweden manufacturing highly refined grades of bessemer and open-hearth steel, seamless steel tubes, wire rods, tool steel, and cold-rolled steel, plant makes broadest strip of cold-rolled, hardened steel so far manufactured, 600 mm.; and has record for making thinnest strip, 0.003 mm. (In English.)

IRON CASTINGS

Chilled, Hardness Testing of. Hardness Testing of Hard Chill Castings (Die Pruefung der Haerte von Schalenhartguss), O. Keune. Kruppsche Monatshefte (Essen), vol. 10, Dec. 1929, pp. 200–203, 2 figs. Features of Brinell and scleroscope hardness-testing methods; it is shown, on basis of various measurements, that last-mentioned method gives widely deviating results in case of hardness testing of hard-chill castings; on the other hand test results check in case of hardened steel; method for calibration of scleroscope.

J

JIGS AND FIXTURES

Welded. Advantages of Arc Welded Jigs, Fixtures, and Machine Tools Demonstrated in Westinghouse Manufacturing Plant, J. R. Weaver. Automotive Industries, vol. 62, no. 6, Feb. 8, 1930, pp. 186–188, 5 figs. Design of machine tools, jigs, and fixtures so that they may be arc welded; with welded structure most complicated jib can be obtained in not more than one week's time; welded jigs normalized to remove strains by heating in furnace to 1000 deg. fahr. after which they are allowed to air cool; further development necessary before application to general production of shop equipment; reduction of 25 per cent in average cost, with less weight.

K

KINEMATICS

Importance in Machine Construction. Importance of Kinematics for the Construction of Machinery (Die Bedeutung der Getriebelehre fuer den Bau von Verarbeitungsmaschinen), H. Alt. V.D.I. Zeit. (Berlin), vol. 74, no. 5, Feb. 1, 1930, pp. 139–144, 16 figs. It is shown that theory of driving movements has developed from kinematics of Reuleaux to independent science of practical importance; principal requirements for movement design of machinery; examples and problems from practical application; reasons which interfere with development and practical application of kinematics.

Nutating Disk Drives. Graphical Kinematics of Nutating Disk Drives (Graphische Kinematik des Taumelscheibentriebes), K. Federhofer. Zeit. fuer Angewandte Mathematik und Mechanik (Berlin), vol. 9, no. 4, Aug. 1929, pp. 312–318, 8 figs. Toilsome calculations involved in computing velocities and accelerations in this type of drive are replaced by simple graphical method, which can be developed from new method of presentation of Mayor and Von Mises.

L

LATHES

Cutting Pressures. Measurement of Cutting Pressure on Lathe by Means of Electric Dynamometer (Schnittdruckmessungen an der Drehbank mit einer elektrischen Messdose), W. Mauksch. Wissenschaftliche Veroeffentlichungen aus dem Siemens-Konzern (Berlin), vol. 8, no. 2, July 8, 1929, pp. 130–136, 6 figs. Practical application of condenser principle for measuring of cutting pressure and its practicability is indicated by experiments by which laboratory equipment and standard lathe have been used.

Tools, Cutting Capabilities of. Cutting Capabilities of Lathe Tools, D. Smith. Mech. World (Manchester), vol. 87, nos. 2244 and 2245, Jan. 3, 10, and 17, 1930, pp. 3–6, 27–29, and 56–59, 14 figs. Jan. 3: Development of cutting metals, their chemical composition and functions are outlined, including Stellite, Cooperite, Widia, and Perdurum; heat treatment of tool steel; cold hardness tests of tool steels. Jan. 10: Hot-hardness tests of tool steel; hot tests of work materials; induced hardness; cutting capacity; cutting speed with heavy cuts; change in ratio of depth of cut to traverse. Jan. 17: Plan and cutting angles, and nose radius of steel; durability with change in tool cross-section; variation in cutting speed with change in depth of cut and traverse; cutting speeds on cast iron; forces exerted on tool at slow and at normal speeds. Abstract of paper presented before North-East Coast Instn. Engrs. and Shipbldrs.

LEAD

Properties of. Physical Constants of Lead, J. E. Harris. Am. Soc. for Steel Treating—Trans., vol. 17, no. 2, Feb. 1930, pp. 282–287. Constants given are atomic weight, isotopes, allotropic modifications, density, crystal form, melting point, boiling point, critical temperature, heat of fusion, heat of vaporization, thermal conductivity, electrical resistivity, electrode potential, viscosity, optical properties, tensile strength, elongation and hardness, elastic limit and Youngs' modulus. Bibliography. Recommended practice committee release.

LOCOMOTIVES

Diesel. Completion of the First 1200-Hp. Diesel Locomotive for the German Governmental Railroad (Die Fertigstellung der ersten 1200 PS-Diesel-Lokomotive fuer die Reichsbahn), Witte. Glasers Annalen (Berlin), vol 106, no. 3, Feb. 1, 1930, pp. 35–39, 3 figs. Diesel compressed-air-2-C-2 locomotive is described in some detail; Diesel engine is of M.A.N. type 1000- to 1200-hp. at 450 r.p.m.; water cooling is used; driving gear operated by compressed and heated air of 7 atmos. and 350 deg.; length of engine is 75.8 m., weight in operating conditions is 126 tons; simplicity of operation is featured.

Developments in Diesel Traction. Gas and Oil Power (Lond.), vol. 25, no. 292, Jan. 2, 1930, pp. 63–64, 1 fig. Recent development in locomotive history has been effected by German State Railways, who have constructed 1200-hp. Diesel-engined locomotive employing compressed-air drive; air pressure of 103 lb. per sq. in., heated by exhaust of Diesel, and then actuates normal locomotive cylinders; comparison with Diesel-electric drive; table giving operating cost; comparison of performance of Diesel-electric and steam locomotives.

Railway Traction by Oil-Engines, A. E. L. Chlorlton. Instn. Civil Engrs.—Minutes of Proc. (Lond.), no. 4716, 1929, 32 pp., 10 figs. Discussion of Diesel propulsion for railroad traction; comparison of efficiencies; suitability for railway service; table giving comparative prices of coal, fuel oil, and Diesel oil per ton; comparative test results of several Diesel locomotives; table of costs of operation of steam and oil-electric locomotives; typical oil-electric equipments.

Electric. French Railway Adopts 5300-Horsepower Electric Locomotives, M. Japiot. Ry. Age, vol. 88, no. 7, Feb. 15, 1930, pp. 427–429, 3 figs. Paris, Lyons, Mediterranean railway using unusually large single-cab electric passenger experimental locomotives of singular design; engines designed to fit particular needs of high-speed service on Mont-Cenis line; electrical apparatus; driving wheels, 63 in.; total locomotive wheelbase 68 ft. 3 in.; total weight of locomotive 351,000 lb.; continuous rating of tractive force 28,700 lb.; maximum speed 81 m.p.h.

Rack Adhesion Locomotives of the Viège Zermatt Railroad (Switzerland) [(Locomotives à crémaillere et a adhérence du chemin de fer électrique Viège-Zermatt (Suisse)], P. Altorfer. Génie Civil (Paris), vol. 96, no. 6, Feb. 8, 1930, pp. 125–128, 7 figs. Engines made by Oberlikon Works of Bo-Bo type operates at 15,000 volt; capacity is 650 hp., tractive effort is 8650 kg., driving wheel diameter 926 mm., total length 15.10 m., speed on adhesion sections 45 km., from 14 to 20 km. on slopes ranging from 40 to 115 per cent; details of 35 km. line and equipment.

High-Pressure. A New High-Pressure L.N.E.R. Locomotive. Mech. World (Manchester), vol. 87, no. 2247, Jan. 24, 1930, pp. 80–81, 3 figs. Description of high-pressure locomotive built at Darlington Works of London North-Eastern Railroad, boiler being built by Yarrow and Co., Glasgow; use of pressure of 450 lb. per sq. in. necessitated complete change in all ordinary boiler practices; special forms of safety valves, regulator, water gage, and injectors had to be provided.

British Build 4–6–4 Type Locomotive of Novel Design. Ry. Age, vol. 88, no. 8, Feb. 22, 1930, pp. 473–474, 4 figs. Engine just completed on London and North Eastern Railway to designs of H. N. Gresley is for express passenger work, has four compound cylinders and boiler pressure is 450 lb. per sq. in.; cylinders, 12 by 20 by 26 in.; weight of engine, in working order, 103.6 tons; total engine wheelbase 40 ft. 0 in.; rated maximum tractive force 40,040 lb.; description of boiler auxiliaries, running gear and tender.

New Schwartzkopff-Loeffler High-Pressure Locomotive (Eine neue Hochdrucklokomotive der Deutschen Reichsbahn Bauart Schwartzkopff-Loeffler), Fuchs. Waerme (Berlin), vol. 53, no. 6, Feb. 8, 1930, pp. 81–86, 7 figs. Account of measures taken to improve efficiency of locomotives by means of tests with turbine and high-pressure locomotives; details of Schwartzkopf-Loeffler locomotive, and application of Loeffler steam-circulating process; design and operation, savings expected, and advantages of this locomotive, built for German Government Railway, are set forth.

Improvements in. On the Question of Improvements in the Steam Locomotive (Subject VI for Discussion at the eleventh Session of the International Railway Congress Association), H. N. Gresley. Int. Ry. Congress Assn.—Bul. (Brussels), vol. 11, no. 11, Nov. 1929, pp. 2689–2819, 23 figs. Contents of report divided into following chapters: increased boiler pressure; superheating; feedwater heating; air preheating; valves and valve gear; arrangement of front end.

On the Question of Improvements in the Steam Locomotive (Subject VI for discussion at the eleventh session of the International Railway Congress Association) T. Bals. Int. Ry. Congress Assn.—Bul. (Brussels), vol. 11, no. 11, Nov. 1929, pp. 2421–2497, 29 figs. Increased pressures and high superheats; improvements in design of superheaters and parts connected with superheating; feed water heating and air preheating; improvements of valve gears.

Internal - Combustion. Railway Traction by Oil Engines, A. E. L. Chorlton. Engineering (Lond.), vol. 129, no. 3341, Jan. 24, 1930, p. 110. Cost of oil locomotive is only half that of steam locomotive; in case of oil-electric train, new standard of reliability, exceeding that of steam locomotive, may have been set up; in addition to higher efficiency and easier maintenance and control, its operation under traffic conditions has several advantages; units up to 200 tons can be controlled by one man and fueling services greatly reduced. Abstract of paper read before Instn. Civil Engrs. Jan. 14, 1930.

New Types. On the Question of Locomotives of New Types; in Particular Turbine Locomotives and Internal Combustion Motor Locomotives (Subject V for Discussion at the Eleventh Session of the International Railway Congress Association), Cossart. Int. Ry. Congress Assn.—Bul. (Brussels), vol. 11, no. 11, Nov. 1929, pp. 2397–2420. Discussion of turbine and Diesel locomotives; high-pressures locomotives; general considerations; report covers Belgium, France, Italy, Portugal, Spain, and their Colonies.

Passenger. Fourteen 4–6–4 Type Locomotives for the Milwaukee. Ry. Age, vol. 88, no. 9, Mar. 1, 1930, pp. 559–560, 1 fig. Description of locomotive for heavy passenger service over Chicago and Milwaukee and LaCrosse and River divisions; features of design and special equipment; cylinders 26 in. by 28 in.; driving wheels 79 in.; steam pressure 225 lb. per sq. in.; rated maximum tractive force 45,820 lb.; total engine weight in working order is 375,850 lb.; total engine wheelbase 40 ft. 9 in.

Pacific Type Locomotives for the Rutland. Ry. Age, vol. 88, no. 7, Feb. 15, 1930, pp. 437–438, 3 figs. Description of locomotives placed in passenger service between Troy and Rouses Point; scheduled time reduced 30 min.; cylinders 25 in. by 28; driving wheels 73 in.; steam pressure 215 lb. per sq. in.; tractive force 43,800 lb.; total weight of engine in working order 292,500 lb.; total engine wheelbase 36 ft. 11 in.

Repair Shops. Canadian National Builds Large Shop at Montreal. Ry. Age, vol. 88, no. 9, Mar. 1, 1930, pp. 549–555, 7 figs. Canadian National Railways build locomotive erecting and machine shop at Point St. Charles, Montreal; building is 1056 ft. long by 265 ft. wide; shop incorporates many unique features of construction, arrangement and operation.

Steam-Turbine. Tests With the Turbine Locomotive of Krupp-Zoelly (Die Versuche mit der Turbinenlokomotive von Krupp-Zoelly), H. Nordmann. V.D.I. Zeit. (Berlin), vol. 74, no. 6, Feb. 8, 1930, pp. 173–176, 10 figs. New engine including tender is 23.44 m. long, steam pressure 15 atmos.; gear ratio from 8000-r.p.m. 1250-hp. Zoelly turbine to main axle is 24.3 to 7; speed is 110 km. per hr.; future developments; changes in original design; heat economy features and performance are discussed.

Valve Gears. 4–6–0 Type Four-Cylinder Locomotive Fitted With Beard More-Caprotti Valve Gear Engineering (Lond.), vol. 129, no. 3342, Jan. 31, 1930, pp. 132–134, 8 figs.; see also Engineer (Lond.), vol 149, no. 3864, Jan. 31, 1930, p. 132, 13 figs. Details of modification carried out on London and North-Eastern Railway system; whole of valve gear works in oil baths; closing of steam and exhaust valves is controlled by springs.

Method for Standardization of Valve Gear of Reciprocating Steam Locomotives (Ein weg zur Vereinheitlichung der Steuerungen gefeuerter Kolben Dampflokomotiven), K. Ewald. Glasers Annalen (Berlin), vol. 106, nos. 1 and 2, Jan. 1, 1930, pp. 3–7, and Jan. 15, pp. 15–19, 6 figs. Jan. 1: Mathematical design analysis pertaining to Walschaert Heusinger valve gear. Jan. 15: Standardized piston valves; internal and external valve gears.

R. C. Poppet Valve Gear as Applied to London and North Eastern Railway 3-Cylinder, 4–4–0 Type Engines, Class D.49. Int. Ry. Congress Assn.—Bul. (Brussels), vol. 11, no. 12, Dec. 1929, pp. 3327–3234, 4 figs. Three-cylinder express passenger locomotives are considered with rotary cam poppet valve gear; description of valve arrangement and cam-shaft action; longitudinal section through cylinders and valves.

LUBRICATION

Research. Friction-Coefficient Research, L. Illmer. Soc. Automotive Engrs.—Jl., vol. 26, no. 1, Jan. 1930, pp. 67–86, 18 figs. Experimental result of different investigators correlated and principles common to all tests in which frictional resistance depends primarily upon fluid shear established; behavior during starting; viscosity determinations; maximum contact factors; journal test discussed; little research directed to friction losses as found in automobile-crankshaft bearings; lack of efficient lubrication of drives responsible for colossal motive-power losses; reasonably reliable method for predetermining certain kinds of friction losses.

Theories. Modern Theories of the Structure of Lubricating-Oil Films (Neuere Theorien ueber den Aufbau des Schmiero elfilmes), A. V. Blom. Petroleum (Berlin), vol. 25. no. 46, Nov. 13, 1929 (Supp.), pp. 3–6, 2 figs. In addition to gliding speed, surface pressure, and play of bearings, knowledge of surface properties of contact metals and capillary properties of oils are necessary in order to define lubrication process; only by consideration of all these factors is it possible to obtain basis for exact formulation of problem; and combined efforts of chemist and engineer are required to solve difficult problem of lubrication process.

M

MACHINE TOOLS

Cutting Pressure. Researches on the Cutting Force, M. Okoshi. Inst. Phys. and Chem. Research—Sci. Papers (Tokyo), vol. 12, no. 220, Jan. 15, 1930, pp. 167–192, 22 figs. Description of ordinary methods for measuring cutting force of machine tools, including brake, work-done, balance, diaphragm, and capacity-change methods; new measuring methods outlined include preliminary test, strength of quartz, planing-tool dynamometer, improved lathe-tool dynamometer, improved drill dynamometer; improved milling-tool dynamometer; switch mechanism; method of measuring piezoelectric charge.

[See also AUTOMOBILE PLANTS.]

MACHINERY

Manufacture, Temperature Effect on Large Pieces. Influence of Difference in Temperature on Change in Shape of Large Workpieces (Der Einfluss von Waermeunterschieden auf die Formaenderung grosser Werkstuecke), C. Krug Werkstattstechnik (Berlin), vol. 24, no. 1, Jan. 1, 1930, pp. 11–13, 4 figs. Relations between temperature difference, degree of density and precision of fit in machining are mathematically analyzed.

Tungsten Carbide Overlays. Welded-On Overlays in Machine Design, M. C. Smith. Am. Mach., vol. 72, no. 6, Feb. 6, 1930, pp. 265–267, 11 figs. Discussion of how tungsten carbide and similar materials can be deposited by welding torch or arc to form local wear-resistant surfaces on machine parts.

Welded, Design of. General Principles of Welded Designs, A. M. Candy. Nebraska Blue Print, vol. 29, no. 4, Jan. 1930, pp. 114–117, 12 figs. Maximum advantages inherent in using arc welding can only be gained by designing work specifically for welding; designs of welded piece for bedplate, welded rotor and other parts are discussed; continuity of beam.

MATERIALS HANDLING

Cargo Handling. Lowers Cost of Cargo Handling, H. E. Stocker. Mar. Rev., vol. 60, no. 3, Mar. 1930, pp. 50–51 and 60, 7 figs. Types of mechanical cargo-handling equipment recently installed at New York terminal of American Hawaiian Steamship Co., where total of approximately 600,000 tons of cargo are handled annually.

Coal. Plant for Unloading of Coal in Dresden Municipal Electric Westkraftwerke (Anlagen fuer die Zufuhr und Lagerung der Kohle im Westkraftwerk der Staedtischen Elektrizitaetswerke in Dresden, ausgefuehrt von den Mitteldeutschen Stahlwerken Lauchhammer), Schlegel. Foerdertechnik und Frachtverkehr (Wittenberg), vol. 22, no. 24, Nov. 22, 1929, pp. 453–457, 6 figs. Description of modern coal storage yard in form of half circle using 70-m. swinging radial overhead track construction with traveling cab; cab and grab are shown in some detail.

Industrial Plants. Organizing Factory Traffic, W. A. Bechill. Nat. Safety News, vol. 21, no. 2, Feb. 1930, pp. 15–16, 1 fig. Traffic in busy factory duplicates on smaller scale conditions of street; orderly plant arrangement, careful training of drivers and maintenance of equipment are needed.

Lumber Mills. Hoisting Apparatus and Bulk Conveyors (Hebezeuge und Massenfoerderer). Foerdertechnik und Frachtverkehr (Wittenberg), vol. 23, no. 4, Feb. 14, 1930, pp. 74–77, 15 figs. Discussion and description of hoisting and transport apparatus used in saw mills and lumber storage yard; tower slewing, traveling crane, log handling cranes, and conveyors are shown in some detail.

Sheet-Metal Working. Materials Handling in the Stamping Plant, A. K. Burditt and W. F. Schaphorst. Metal Stampings, vol. 3, no. 2, Feb. 1930, pp. 113–117, 8 figs. Description of various types of trucking equipment and platforms, together with their specific applications and advantages for handling and storage of stampings.

METALS

Cutting, Theory of. Cutting Theory (Ueber die Zerspannungstheorie), H. Friedrich. Maschinenbau (Berlin), vol. 9, no. 2, Jan. 16, 1930, pp. 47–51, 2 figs. Methods of scientific investigation and application; comparison with modern methods of research for cutting resistance and cutting speed, limiting values as basis for conformity of theory and practice.

Deformation. Dynamische und Statische Zugversuche an Aluminium-Einzelkristallen, J. Weerts. (Forschungsarbeiten. . . heft 323.) Berlin. V.D.I. Verlag, 1929, 20 pp., illus., diagrs. 4.—r.m.; see also abstract in V.D.I. Zeit. (Berlin), vol. 74, no. 1, Jan. 4, 1930, pp. 21–22, 1 fig. Investigation of reasons for observed effect of speed of deformation of ductile metals upon their resistance to deformation; author investigated behavior of large aluminum crystals when subjected to various tests of their tensile strength; new light was obtained upon phenomena of crystal deformation and resistance. Eng. Soc. Lib., N. Y.

Drawing. The Testing of Thin Sheet Metal, E. Siebel and A. Pomp. Metallurgist (Supp. to Engineer, Lond.), Jan. 31, 1930, pp. 6–7. With view to overcoming difficulties of ordinary tensile test as applied to thin sheet metal, and at same time affording measurements of ductility of material, authors have devised new form of cupping which is described. Review of paper indexed in Engineering Index, 1929, from Mitteilungen aus dem Kaiser-Wilhelm-Institut fuer Eisenforchung, vol. 11, 1929.

Elongation. Significance and Evaluation of Elongation of Metals (Zur Deutung und, Bewertung der Bruchdehnung bei Metallen)v W. Kuntze. Zeit. fuer Metallkunde (Berlin), vol. 22, no. 1, Jan. 1930, pp. 14–22, 17 figs. It is claimed that maximum elongation is not proof of resistance to rupture; results of tests in which influence of elongation under bending and torsion, and its relation to strain hardening and decay of material relations between elongation and notch touchness, etc., are determined.

Fatigue. Derivation of Vibration Strength from Tensile and Cohesive Strength (Berechnung der Schwingungsfestigkeit aus Zugfestigkeit

und Trennfestigkeit), W. Kuntze. V.D.I. Zeit. (Berlin), vol. 74, no. 8, Feb. 22, 1930, pp. 231–234, 3 figs. Report on experimental and theoretical studies made at Materials Testing Bureau of Dahlem, which resulted in formula for numerical relationship between vibration strength and cohesive strength of steel, copper, aluminum, and various alloys as manifested in tension-compression and in bending fatigue tests; formula allows substitution of several notched-bar tension tests for complicated procedure of vibration and fatigue testing.

The Failure of Steel Castings and Forgings Through Fatigue. North-East Coast Inst. of Engrs. and Shipbldrs.—Advance Paper (Newcastle-Upon-Tyne), for mtg. Jan. 24, 1930, 14 pp., 4 figs. on supp. plates. Rather loose application of term fatigue is discussed; one type of fracture only is classed as fatigue fracture others described being barred; erroneous conceptions of fatigue are discussed and its mechanism is described; metallurgical and mechanical aspects are dealt with, and ways avoiding fatigue are suggested; number of examples of fatigue failures are briefly described.

Temperature Effects. Effect of Small Changes in Temperature on the Properties of Bodies, M. D. Hersey. U. S. Bur. of Standards—Jl. of Research, vol. 4, no. 1, Jan. 1930, pp. 137–156. After reviewing usual methods of solution, general mathematical treatment of problem is given, from which two additional methods are derived that can sometimes be usefully applied: (1) simple calculation, made possible by theory of dimensions, which does not require detailed formula for property in question; and (2) combined theoretical and experimental solution, in which experimental factors have been reduced to minimum; stiffness of steel spring is taken as example.

Wear Testing. Recent Results of Research on Wear of Materials (Neuere Ergebnisse der Abnutzungsforschung), M. Fink. V.D.I. Zeit. (Berlin), vol. 74, no. 3, Jan. 18, 1930, pp. 85–87, 4 figs. Features of Amsler wear-testing machines; results of recent research in Germany, Great Britain, and United States on such subjects as rusting of steel, mechanical production of oxidation in rolling, rail corrugations, etc.

MOTOR TRUCKS

Brakes. Brake Drums and Linings for Motor Trucks, G. B. Ingersoll. Ry. Age, vol. 88, no. 4, Jan. 25, 1930, pp. 289–290, 1 fig. Discussion of how modern transportation conditions making greater demands of braking equipment, are developing better materials for brake drums and moldings; use of ordinary pressed steel drum under heavy braking pressure results in undue wear, regardless of friction material used; question of obtaining sufficient space in which to house drum of proper physical proportions. Abstract of paper presented before Soc. of Automotive Engrs.

N

NITRIDATION

European Practice. Nitriding of Steel in European Practice, J. W. Urquhart. Heat Treating and Forging, vol. 16, no. 1, Jan. 1930, pp. 48–50 and 52. Ammonia-heat method of producing intense local hardness is reviewed; aluminum content is indispensable; hardness of case is comparable to bort; properties of nitrided steel surface; low temperature advantages of nitriding; depth of nitrided zone; preparation of nitralloy steels; steels suggested for nitriding; firing boxes for nitriding; electric resistor furnace used in Europe for nitriding.

NOTCHED BARS

Stresses in. Danger of Notched Sections (Ueber die Kerbgefahr), W. Kuntze. V.D.I. Zeit. (Berlin), vol. 74, no. 3, Jan. 18, 1930, pp. 78–82, 11 figs. Report from Materials Testing Office of Germany giving results of new series of tests; effect of shape and depth of notch on stresses; variable effect of maximum notch stresses in tension and bending upon resistance of test specimen; value of quality of materials for safety of notched sections.

NOZZLES

Discharge. Coefficients of Flow of Standard Nozzles, H. Mueller and H. Peters. Nat. Advisory Committee for Aeronautics—Tech. Memo., no. 549, Jan. 1930, 6 pp., 3 supp. figs. Results of experiments in hydraulic laboratory of Munich Institute of Technology; two standard nozzles for pipes of 2.76 and 6.89 in. in diam. tested, using water as flowing medium; results compared with those of Jacob, Kretzschmer, and Witte; with use of pitot tubes in irregular flow, calculations made with greater error; present flow coefficients apply only to plants geometrically similar to author's.

O

OIL ENGINES

Ruston and Hornsby. An 850 B.H.P. Enclosed Type Vertical Airless-Injection Oil Engine. Engineer (Lond.), vol. 49, no. 3865, Feb. 7, 1930, pp. 166–168, 4 figs. Details of Ruston and Horsby improved type of engine of large output, which has been specially designed for electric lighting, industrial power, and marine auxiliary services; engine is six-cylinder unit.

P

PACKING

Packing for Shipment. Packing Your Product, M. M. Miller. Indus. Woodworking, vol. 30, no. 5, Feb. 1930, pp. 42, 44 and 46, 4 figs. Importance of properly packing goods for shipment, choice of materials, and methods available for this purpose, design, and construction of crates and packages, and where to obtain further specific information.

PENSTOCKS

Jet Dispersers. Hydraulic Jet Dispersers for the Arapuni Power Plant. Engineering (Lond.), vol. 129, no. 3342, Jan. 31, 1930, p. 137, 2 figs. Pipe lines are each being fitted at lower end with Glenfield energy disperser; by means of these, energy of 3000 cusecs of water escaping from each of jets, and amounting to nearly 50,000 hp. will be harmlessly disposed of, water falling on surface of river in form of heavy rain.

PIPE FITTINGS

X-Ray Analysis. X-Raying Large Steel Castings, A. St. John and H. R. Isenburger. Iron Age, vol. 125, no. 7, Feb. 13, 1930, pp. 499–501, 9 figs. Further information given about X-ray inspection of heavy cast-steel pipe fittings for high pressure service, some of which were recently examined on job instead of at laboratory; castings for 1200-lb. pressure steam plant; how current for X-rays was produced; X-ray pictures hard to reproduce.

PIPE JOINTS

Welded. Welded Line Joints for Steel Pipe, W. I. Gaston. Iron Age, vol. 125, no. 6, Feb. 6, 1930, pp. 435–437, 9 figs. Types of welded line joints used today, are considered from standpoints of strength, flow conditions and economy; Vee butt joint is all-purpose joint; square ends preferred on thin walls; closed Vee usable for low-pressure work; couplings sometimes welded to prevent leaks; use of liners.

PLANERS

Metal-Working. New Development in Planers and Grinders. Eng. Progress (Berlin), vol. 11, no. 2, Feb. 1930, pp. 36–37, 5 figs. Single-housing planer installed in works of Billeter and Klunz, A. G., of Aschersleben, has clear width of 5.75 ft., working height of 4.9 ft. and working length of 28 ft.; operation of machine is very simple; ways grinding machines, with width of grinding 3.28 ft., height of grinding 5.2 ft., driving unit 4 hp. motor and pump, are illustrated and described.

PLATES

Rectangular, Stresses in. Transversal Oscillations of Rectangular Plates With Special Regard to Buckling (Transversalschwingungen rechteckiger Platten mit besonderer Ruecksicht der Knickung), H. Grauers. Ingeniors Vetenskaps Akademien (Stockholm), no. 98, 1929, 68 pp., 16 figs. Thorough treatise on strains in rectangular plates subjected to various loadings; it is shown how to find magnitude of evenly distributed external forces, that make equilibrium stable and conditions to which edges are subjected; formulas are derived and tables and diagrams are worked out for various conditions. (In German.)

PRESSURE VESSELS

Welding. Welded Boilers, E. R. Fish. Am. Welding Soc.—Jl., vol. 8, no. 10, Dec. 1929, pp. 24–35, 6 figs. General discussion of methods of welding boilers, both high- and low-pressure; including forge or hammer welding, autogenous or fusion welding, electric resistance welding, and thermit welding; X-ray examination; defects in line welds, girth seams or structural joints may be detected by use of stethoscope.

PUMPS

Rotary Piston. New Tests of Rotary Piston Pumps of Mawald Design (Neue Versuche an umlaufenden Kolbenpumpen, Bauart Mawald), K. Leist. V.D.I. Zeit. (Berlin), vol. 74, no. 6, Feb. 8, 1930, pp. 168–170, 10 figs. Tests of special type of rotary pump, consisting of two rotating interlocking rolls, and having capacity of 5 to 60 cu. m. per hr., speed up to 1500 r.p.m., working against heads up to 15 atmos. and more; efficiency as high as 60 per cent observed, curve showing variation of efficiency with head, viscosity of liquid pumped, etc.; field of application of this type of pump in petroleum, refining, and in chemical industries.

PUMPS, CENTRIFUGAL

Design. Studies of Regulation, Theoretical and Actual Pumping Heads of Centrifugal Pumps (Untersuchungen ueber Regelung, theoretische und workliche Foerderhoehe von Kreiselpumpen), W. Siebrecht. V.D.I. Zeit. (Berlin), vol. 74, no. 3, Jan. 18, 1930, pp. 87–88, 3 figs. Excerpts, from Bulletin No. 321 of Forschungsarbeiten auf dem Gebeite des Ingenieurwesens, on tests made at Braunschweig Institute of Technology, on regulation by admitting of air into suction of pump, effect of various positions of buckets, etc.; discussion of Pfleiderer method of computation for design of centrifugal pumps.

Deep Well. Deep-Well Centrifugal Pumps (Tiefbrunnen-Kreiselpumpen), W. Schulz. V.D.I. Zeit. (Berlin), vol. 74, no. 8, Feb. 22, 1930, pp. 235–238, 9 figs. Hydraulic characteristics of deep wells, particularly drilled wells, and adaptation of pump construction to meet special conditions of deep-well pumping; features of semi-axial types of multi-stage pumps with as many as 12 stages, manufactured by Klein, Schanzlin & Becker; description of several devices for protection of pumps against sand carried in water pumped; economic considerations.

R

RAIL MOTOR CARS

Steam. Oil-Fired, Superheated- Steam Rail Motor Cars (Heissdampftriebwagen mit Oelfeuerung), O. Guenther. V.D.I. Zeit. (Berlin), vol. 74, no. 4, Jan. 25, 1930, p. 118, 1 fig. Type developed by Esslingen Machine Works of Venezeuelan railroads; car weighs 35 kg. tons and has 42 seats; trailer has 32 seats and weighs 16 tons; Venezuelan oil was used on test stand for average loading at 30.2 km. per hr.; 130 kg. was fired without leaving residues; steam is superheated 340 to 380 deg. cent.; 135 hp. developed, yielding tractive effort of 1205 kg.; operating speed approximately 50 km. per hr.

REFRACTORY MATERIALS

Heat Conductivity. Measuring Thermal Conductivity of Refractory Materials at High Temperatures (Waermeleitfaehigkeitsmessungen und Feuerfesten Materialien bei Hohen Temperaturen), A. Eucken and H. Laube. Tonindustrie Zeitung (Berlin), vol. 53, no. 91, Nov. 14, 1929, pp. 1599–1602, 4 figs. Spherical heating element wound with platinum wire is used; material to be tested is made into two hemispheres surrounding heating elements; thermocouples are embedded in concentric grooves and lead wires are brought to surface at considerable distance from junctions.

REFRIGERATING PLANTS

Pumps. Pumps for Ice Plants and Refrigerating Plants, J. J. Alden. Southern Power Jl., vol. 48, no. 2, Feb. 1930, pp. 79–87, 11 figs. Discussion of pumping requirements for ice-making plants; variable speed drives; curves showing combined capacity of centrifugal pumps operating parallel; direct acting steam pumps; provision for testing; straight line diagram for use in solution of pump problems; angle of impeller vanes.

REFRIGERATION

Heat Transmission and. Heat Transmission and Refrigeration, C. S. Keevil. Refrig. Eng., vol. 19, no. 2, Feb. 1930, pp. 41–44, 3 figs. Review of recent work; graphical method of resolving overall heat transmission coefficients into individual resistances; affect of heat transmission on fluid friction; discussion of importance of economic balance between fixed charges and operating costs; attention called to several papers which contain test results and analytical methods related to question of heat transmission. Bibliography.

Low-Temperature. Developments in Application of Low-Temperature Brine Freezing. Cold Storage (Lond.), vol. 32, no. 381, Dec. 19, 1929, pp. 391–392, 3 figs. Development of quick freezing brings nearer, for all connected with production, preparation, marketing, and consumption of perishable foods, facility which bids fair to place them on even footing with producers and manufacturers of non-perishable goods; survey of quick-freezing methods.

Tendencies in. A Survey of Tendencies in Modern Refrigerating Design, B. C. Oldham. Cold Storage (Lond.), vol. 32, no. 382, Jan. 16, 1930, pp. 8–11, 3 figs. Discussion of compressor efficiencies and some outworn theories; development of modern high-speed practice, and valve design, which is limiting factor; charts of power absorbed in compressors; curves showing refrigerating effect of solid carbon dioxide compared with same volume of secondary refrigerants. Paper presented before Brit. Assn. of Refrig.

RESEARCH

Germany. The Young Plan and Scientific Research (Young-Plan und wissenschaftliche Forschung), C. Matschoss. V.D.I. Nachrichten (Berlin), vol. 10, no. 6, Feb. 5, 1930, pp. 1–2. Author discusses paramount role which scientific and technical research must play in reconstruction of Germany; data on research funds available in United States; American manufacturing industries as employers of labor; lesson from American experience is that scientific research is only remedy for unemployment; author urges cooperation between general press and scientific and technical organizations.

ROLLING MILLS

Anti-Friction Bearings. A Review of the Proceedings of A.I. and S.E.E. in Connection with the Development of Anti-Friction Bearings in the Iron and Steel Industry, D. M. Petty. Iron and Steel Engr., vol. 7, no. 1, Jan. 1930, pp. 12–20. Review of data and information on what Association of Iron and Steel Electrical Engineers has compiled in connection with anti-friction bearings.

Blooming Mills. A New Three-High Blooming and Slab-Blooming Mill. Iron and Steel Industry (Lond.), vol. 3, no. 4, Jan. 1930, pp. 107–110, 8 figs. Description of three-high (blooming and) slab blooming mill suited for dealing with blooms weighing up to 2 tons each, which has been added to rolling plant of Societe Italiana Ernesto Breda, Milan; without changing rolls mill is capable of rolling blooms of 1 ft. 4 and 9/16 in. and 10 in. down to billets of 7 and 1/8 in. and 4 in. cross section or to any other rectangular section within these limits.

Cooling Beds. Mechanization of a Pipe and Strip Mill (Mechanisierung einer Walzenstrase fuer Roehrenstreifen und Bandeisen), B. Quast. Stahl und Eisen (Duesseldorf), vol. 50, no. 7, Feb. 13, 1930, pp. 206–207, 4 figs. Reconstruction of two-high rolling mill is described; double strip bed, patented by Maschinenfabrik Quast, Rodenkirchen, was installed, which is entirely automatic and has advantage of simplicity in design and low initial and operating costs; double cooling bed together with shears for strips of 450 mm. is illustrated.

Design. Roll Pass Design, W. Trinks. Rolling Mill Jl., vol. 4, no. 2, Feb. 1930, pp. 49–53, 15 figs. Causes of formation of fins and overfills in rolling and methods by which they may be avoided are outlined; in general these effects can be minimized by rounding or chamfering corners of passes and use of convex box passes.

Electric Control. Steel Mill Auxiliary Control Specification Guide Forms. Iron and Steel Engr., vol. 7, no. 1, Jan. 1930, pp. 1–8. Set of guide forms which have been compiled to enable purchasing agents, steel-mill engineers and their assistants properly to prepare requisitions for d.c. magnetic control apparatus; resistor applications; general guide forms given for specifying non-reversing d.c. magnetic controllers, reversing or reversing-plugging d.c. controllers, reversing dynamic braking d.c. magnetic controllers, and d.c. crane protective, switchboard and panels.

Electric Drive. Electrical Drives for Steel Plants, A. F. Kenyon. Iron and Steel Engr., vol. 7, no. 1, Jan. 1930, pp. 20–23, 3 figs. Description of new electric drive which has been installed during 1929; during year approximately 300,000 hp. in main roll drives of 300 hp. and larger, have been sold, making total capacity on main roll drives more than 2,500,000 hp.; truck-type circuit breakers extensively applied with satisfactory results.

Filling Roll Passes. Filling of Roll Passes (Das Fuellen von Kalibern), W. Tafel and G. Wagener Stahl und Eisen (Duesseldorf), vol. 50, Jan. 30, pp. 126–128, 6 figs. Investigation of method developed by S. Ekelund for determination of ingot depth of irregular passes by means of practical tests; in most cases failure resulted; agreement with Tafel method of calculation is confirmed.

S

SAWS, WOODWORKING

Electric Control. Band-Saw Control Saves Production Time, L. O. B. Lindstrom. Elec. World, vol. 95, no. 5, Feb. 1, 1930, p. 263, 1 fig. Plugging and slow-down control developed for high-speed band saw; sawing logs which saw speed of 10,000 ft. per minute at Susanville and Hilt plants of Fruit Growers' Supply Co., California, is discussed; diagram of control is given.

SCREW THREADS

Standardization. Screw-Threads Division. Soc. Automotive Engrs. Jl.—Reports of Divisions to Standards Committee (Section 2), Jan. 1930, pp. 50–55, 10 figs. Proposed revision of American standard and S.A.E. standard for wrench head bolts and nuts and wrench openings; proposed American standard and S.A.E. standard for slotted-head screws; line cuts and dimensions given for flat, round, oval, and fillister-head machine screws, flat, button and fillister-head capscrews, round, flat, and oval-head wood screws, and brass and steel wood screws.

SPRINGS

Torsional. New Torsional Spring Formulas, J. K. Wood. Iron Age, vol. 125, no. 4, Jan. 23, 1930, pp. 303–306, 9 figs. Formulas are given for helically or spirally coiled springs, arranged to resist rotary motion or torque, which are called torsional springs; correction to standard stress formulas essential with small coil diameters; conventional methods may be far in error; basis of current design practice; formula for correction of deflection; cumulative effect is important; formulas for safe maximum stress and load-deflection rate.

STEAM CONDENSERS

Cleaning. Determination of Economically Favorable Period Between Cleaning of Condensers (Ermittlung des wirtschaftlich guenstigsten Zeitraumes zwischen zwei Kondensatorreinigungen), H. Quednau. Elek-trizitaetswirtschaft (Berlin), vol. 29, no. 500, Jan. 2, 1930, pp. 40–41, 2 figs. Economic analysis of factors involved, i.e., balance between costs of cleaning and heat losses resulting from too long delay, in cleaning.

Surface. Direction of Tube Axis, and Mean Axis of Flow Into Tube Bank in Surface Condensers, T. Petty. Mech. World (Manchester), vol. 87, no. 2246, Jan. 17, 1930, pp. 53–54, 2 figs. Exhaust inlet branch of relatively large size situated centrally between tubeplates of two-pass condenser is sufficiently near theoretically correct position; principle may serve as guide to rational procedure in condensers of special type, as in single-pass naval condensers, or in low-vacuum condensers.

STEAM-ELECTRIC POWER PLANTS

Design. Design of Modern Super Plants (Bau neuzeitlicher Gross-kraftwerke), A. Bannwarth. Elektrotechnische Zeit. (Berlin), vol. 51, no. 6, Feb. 6, 1930, pp. 209–212, 1 fig. Arrangement of building and space requirements are discussed from standpoint of modern steam and equipment practice.

Pressure Control for. Steam Pressure Control for Stations Operating on a Two Pressure System, J. L. Kimball. Combustion, vol. 1, no. 8, Feb. 1930, pp. 30–33, 3 figs. Discussion of central generating stations operating under two-pressure systems; effective utilization of high-pressure steam gives rise to numerous questions affecting selection and arrangement of pressure-control valves, especially during period when it is necessary to operate with two pressures before station is completely changed over to high-pressure cycle.

STEAM HEATING PLANTS

District, New York City. Steam Service From Central Stations in New York City, W. J. Baldwin, Jr. Nat. District Heat. Assn.—Bul., vol. 15, no. 2, Jan. 15, 1930, pp. 84–97. Comprehensive discussion of present activities of New York Steam Corp., which is only public utility supplying steam under franchise in New York City; types of buildings supplied with steam; description of piping system; list of new large buildings which are purchasing steam; description of steam generating plants and their operation. Paper read before Am. Soc. Heat. and Vent. Engrs.

STEAM POWER PLANTS

High-Pressure. Developments in the Generation of High-Pressure Steam, I. E. Moultrop and M. D. Engle. Iron and Coal Trades Rev. (Lond.), vol. 120, no. 3233, Feb. 14, 1930, p. 285, 2 figs. Enumeration of high-pressure stations now under construction in United States; brief description of principal features. Abstract of paper read before Instn. of Engrs. and Shipbldrs. in Scotland.

High-Pressure Extensions to the Issy-Les-Moulineaux Power Station. Engineer (Lond.), vol. 149, no. 3866, Feb. 14, 1930, pp. 178–180, 4 figs. For supply of high-pressure steam six boilers were provided, each designed to evaporate normally 70 tons of water per hour; coal is prepared in separate pulverizing house, with capacity of 900 tons per day; boilers are of three-drum bent-tube type; metal employed is basic Siemens-Martin steel; all accessories of high-pressure pipe system are of forged steel, except bodies of valves, for which cast steel was employed.

The Generation of Superpressure Steam, S. Loeffler. Engineering (Lond.), vol. 129, no. 3339, Jan. 10, 1930, pp. 58–60, 10 figs. Considerations set forth are based mainly on experience with author's boiler, characteristic feature of which is that water is evaporated in non-fired vessel or container, by pumping through it supply of superheated and superpressure steam. Translated from Contribution in Festschrift Prof. Dr. A. Stodola zum 70. Geburtstag, 1929.

The Future of Higher Steam Pressure in Steam-Electric Generating Stations, I. E. Moultrop. Am. Inst. Elec. Engrs.—Paper for mtg., Dec. 2–4, 1929, 3 pp. Biggest problem before station designers today is to reduce cost of construction per unit of capacity; some engineers have suggested that cheaper and less economical stations should be built; high standards of efficiency that have been established and reduced cost of construction by intensive study and better design; better engineering in future is answer to problem.

Industrial, Great Britain. New Developments in British Industrial Steam Station Practice, D. Brownlie. Combustion, vol. 1, no. 8, Feb. 1930, pp. 39–43, 7 figs. Review of British practice in industrial power plants; illustrated description of superviser installations, also description of Atkinson rotary furnace; test results of rotary furnace installation operating standard Lancashire boiler with superheater, but not feed-water economizers.

Industrial, Iron and Steel Plants. Use of Waste Fuels for Power Generation, L. A. Deesz and G. S. Thompson. Blast Furnace and Steel Plant, vol. 18, no. 1, Jan. 1930, pp. 124–129 and 134, 5 figs. Discussion of how Colorado Fuel and Iron Co. uses waste fuels in steel plant at Pueblo, Colorado; Cottrell system for cleaning gas; control of gas flow; central power plant; turbine room; low-pressure steam plants; new design of gas burner; utilizing by-product fuel.

Peak-Load Equalization. Equalization of Power Fluctuations in Steam Power Plants (Der Ausgleich von Energieschwankungen in Dampfbetrieben), B. Gentzcke. Archiv. fuer Waermewirtschaft (Berlin), vol. 11, no. 1, Jan. 1930, pp. 16–22. It is shown that admission and emission of energy can be influenced in many cases even without steam accumulator to such extent that entire plant operates efficiently; examples are given of process steam plants, and steam-electric plants; comparison of different types of accumulators.

University of Chicago. Chicago University's New Steam Plant. Power, vol. 71, no. 5, Feb. 1930, pp. 164–168, 7 figs. Complete costs, operating data and guarantees for three 12,040-sq. ft. boilers, equipped with water walls, economizers, air preheaters, forced-draft chain grate stokers, and combustion control; lists of principal equipment in new boiler plants.

STEAM TURBINES

Governors. Operating Characteristics of Turbine Governors, T. E. Purcell and A. P. Hayward. Am. Inst. Elec. Engrs.—Advance Paper, no. 8, for mtg. Jan. 27–31, 1930, 5 pp., 10 figs. Tests conducted by Duquesne Light Co. of Pittsburgh to determine influence steam turbine governors have in starting or sustaining surge conditions; conclusions assumed are: governor system installed at Colfax Power Station will not start system surging and will not sustain load oscillations.

Specifications. British Standard Specification for Steam Turbines. Brit. Eng. Standards Assn. (Lond.), no. 132, Jan. 1930, 10 pp. Specifications for rating, economical rating, governing characteristics, speed adjustments; emergency cut-off speed; maximum speed; steam or heat consumption; limits of lubricating oil temperature; hydraulic test for parts exposed to boiler-pressure; lubricating oil; parallel running; vibration and noise; critical speed of rotating element; standard equipment.

Testing. Testing of Counter-Flow Back Pressure Turbo-Generator of Ljungstroem-M.A.N. (Versuche an einer Gegenlauf-Gegendruck Turbo-dynamo Bauart Ljungstroem-M.A.N.), K. Hencky and F. Maszmann. V.D.I. Zeit. (Berlin), vol. 74, no. 2, Jan. 11, 1930, pp. 44–46, 5 figs. Unit of 7200 kw. rated capacity at 30 atm. and 370 deg. cent. temperature at valve and 6.5 atm. back pressure has yielded 86 per cent efficiency at 7500 kw. load, including all steam losses; results of acceptance tests are given in tabular form.

STEEL

Alloy. See ALLOY STEELS.

Chromium-Nickel. See CHROMIUM-NICKEL STEEL.

Electric Process. Production of Electric Steel for Castings, G. Batty. Am. Soc. Steel Treating—Trans., vol. 17, no. 3, Mar. 1930, pp. 449–459 and (discussion) 459–470, 1 fig. Two sharply differentiated methods of procedure are discussed as being applicable to production of both straight carbon and alloy steel for castings; it is affirmed that, in ordinary conditions that pertain in steel foundry, where scrap contaminated by adherent sand is used as part of charge definite boil of bath must be secured with some inevitable elimination of carbon in order that finely divided non-metallics be cleansed from bath.

Fatigue of. Failure of Steel Castings and Forgings, R. A. MacGregor. Iron and Coal Trades Rev. (Lond.), vol. 120, no. 3232, Feb. 7, 1930, p. 249. Higher stresses are now common in modern construction; conditions predisposing to failure by fatigue are initiated by breaking of first crystal; author described appearance of fatigue fracture, and outlined conditions likely to induce fatigue; elastic-limit function; mechanical aspects of fatigue failures; specific instances of fatigue failures arising from various causes are given in original paper. Brief abstract of paper read before North-East Coast Instn. Engrs. and Shipbldrs.

The Yield Point and the Fatigue Limit, B. P. Haigh. Engineering (Lond.), vol. 129, no. 3344, Feb. 14, 1930, pp. 231–234, 20 figs. Relation between fatigue strength and yield point varies widely with different kinds of steel; ratio of fatigue limit to ultimate strength which is 0.60 with carbon-free metal, sinks to 0.40 or less in case of pearlite; typical diagrams for different metals or reproduced; under certain combinations of steady and alternating stress, there is discontinuity in curve representing fatigue limit, and same pecularity has been observed in other cases. Abstract of paper read before Instn. Automobile Engrs., Feb. 4, 1930.

Heat Treatment. Structural Steel Heat Treated, P. F. Lee and H. A. Schade. Iron Age, vol. 125, no. 7, Feb. 13, 1930, pp. 510–514, 1 fig. Results of investigation undertaken to determine what physical properties could be obtained by heat treatment of hot rolled low-carbon steel, comparable to S.A.E. 1020 steel; preliminary tests on 45 steels; test pieces given various draws after water-quench; high-elastic-limit steel produced by quenching 0.20 carbon 0.60 manganese steel from 1600 deg. fahr. and drawing at 1100 deg.; welded joints respond to same treatment; tests on weldability of structural steel.

The Heat Treatment of Steel, H. Rickli. Engineering (Lond.), vol. 129, no. 3342, Jan. 31, 1930, pp. 141–142. Editorial comment on paper presented before World Power Conference in Tokyo, in which author drew attention to number of cases in which attempt to improve properties of alloy steels by heat treatment had been responsible for explosion of rotors of high-speed three-phase alternators; it seems certain that immediate cause of accidents was internal stresses set up by heat treatment; he suggests abandonment of process of heat treatment, and use for rotors of well-annealed alloy steels.

Ingot-Casting Machines. Steel Billets Are Cast Centrifugally, J. D. Knox. Iron Trade Rev., vol. 86, no. 5, Jan. 30, 1930, pp. 58–60, 4 figs. Description of machine which, by centrifugal means casts eight bars 78 in. long, 18 in. wide, and from 1/2 to 4 in. thick at one time; machine was designed by L. Cammen; unit includes driving medium, pouring trough and cylindrical mold partially fluted on interior; use of casting machine makes soaking pits unnecessary; continuous furnace with racks for storing bars required.

Sheet, for Automobile Bodies. Success of Deep Drawing Operations on Strip and Sheet Steel Depends Upon Microstructure, J. Winlock and G. L. Kelley. Automotive Industries, vol. 62, no. 7, Feb. 15, 1930, pp. 220–223 and 237, 5 figs. Number of most troublesome defects which occur in sheet-steel fabrication with explanation of these phenomena made from actual production problems in plant of Edward G. Budd Mfg. Co.; control of grain size and arrangement at rolling mill and press shop will eliminate them; in deep drawing elongations or stretching of blanked or sheared edge is undesirable. Paper read before Am. Soc. for Steel Treating.

Stainless. Corrosion-Resisting Steels and Their Applications, J. H. G. Monypenny. Iron and Steel Industry (Lond.), vol. 3, no. 4, Jan. 1930, pp. 111–115, 4 figs. General characteristics and mechanical properties of corrosion-resisting steels; difficulties in manufacture of stainless steel of very low carbon content; improvement effected by increasing chromium; if nickel content of austenitic steels be considerably increased their usefulness is extended in certain directions mainly with regard to meeting corrosive attack of certain type at high temperature.

Strain Hardening. Overload Capacity and Dynamic Strain Hardening of Steels (Ueber dynamische Verfestigung und Ueberlastungsfaehigkeit von Staehlen), a. Thum. V.D.I. Zeit. (Berlin), vol. 73, no. 50, Dec. 14, 1929 ,pp. 1787–1788, 5 figs. Excerpts from thesis presented to Darmstadt Institute of Technology; report on experimental studies of so-called strain hardening of steel to withstand higher repeated stresses; experiments with prestressed materials; temperature régime for various fatigue-testing procedures.

Temperature Effect. Steel at Elevated Temperatures, A. Sauveur. Am. Soc. Steel Treating—Trans., vol. 17, no. 3, Mar. 1930, pp. 410–448, 38 figs. Some of physical properties at different temperatures of carbon steels, of austenitic and of non-austenitic steels have been investigated by twisting small grooved bars; factor of stiffness obtained by dividing breaking load in pounds by angle of twist in degrees bring out sharply blue-heat range in some steels; time-strain curves are obtained which throw considerable light on behavior of steel of different compositions when subject to plastic deformation.

Tensile Testing. Tensile Properties of Rail and Other Steels at Elevated Temperatures, J. R. Freeman, Jr., and G. W. Quick. Am. Inst. of Min. and Met. Engrs.—Tech. Pub., no. 269, for mtg. Feb. 1930, 48 pp., 38 figs. Notes on special study of tensile properties, in approximate temperature range of 400 to 700 deg. cent.; ductility decreases with temperature increase, over a portion of range; elongation and reduction of area decrease at 500 to 650 deg.; data on rate of cooling and temperature distribution are also given. Bibliography.

STEEL CASTINGS

Silicon Steel. Properties of Silicon Steel in Form of Steel Castings (Ueber die Eigenschaften von siliziumlegiertem Stahl in Form von Stahlguss), E. H. Schulz and F. Bonsmann. Stahl und Eisen (Duesseldorf), vol. 50, no. 6, Feb. 6, 1930, pp. 161–168, 14 figs. Investigations of six silicon-steel mixtures in comparison with unalloyed steel castings; strength properties with and without annealing; influence of annealing temperature; tensile and notched-bar tests after different pretreatments at minus 80 to plus 500 deg. cent.; results of wear and corrosion tests.

STOKERS

Traveling - Grate. Automatic Traveling-Grate Stokers for Boilers (Selbsttaetige Wanderrostfeuerung fuer Dampfkessel), F. Generlich. Archiv. fuer Waermewirtschaft (Berlin), vol. 11, no. 2, Feb. 1930, pp. 33–37, 6 figs. Description of Bosselmann pendulum grate with automatic feed and draft regulation; based on results of tests it is estimated that efficiency is increased 5 per cent by use of automatic in place of hand control.

T

TESTING MACHINES

Brittleness. New Italian Machine for Determination of Brittleness of Metals (La recente macchina italiana per la determinazione della fragilità dei metalli), E. De Lutüs. Ingegnere (Rome), vol. 3, no. 11, Nov. 1929, pp. 720–722, 4 figs. Construction and use of machine invented by Castiello and adopted by Royal Navy of Italy; machine determined resilience exactly without corrections, hardness and resistance approximately.

Dead-Weight. A New Dead-Weight Testing Machine of 100,000 Pounds Capacity, L. B. Tuckerman, H. L. Whittemore, and S. N. Petrenko. U. S. Bur. Standards—Jl. of Research, vol. 4, no. 2, Feb. 1930, pp. 261–264, 4 figs. on supp. plates. Functions of Bureau of Standards; and importance of calibrating testing machines; development of proving ring; need for apparatus for applying, preferably by dead weights, forces which are known accurately; dead-weight machine which has been installed at Bureau; particular attention is given to accuracy of forces which can be applied by this machine and precautions for maintaining accuracy.

Torsion. Machines for Determining Torsional Fatigue Developed in Germany. Automotive Industries, vol. 62, no. 6, Feb. 8, 1930, pp. 193–194, 2 figs. Description of two machines for testing specimens for endurance under alternating torsional loads; one manufactured by Losenhausenwerk of Duesseldorf Machine Works, subjects specimen to fixed preliminary torsional load, superimposed upon which is rapidly alternating torsional load; other, manufactured by Carl Schenk Foundry and Machine Works, Darmstadt, test specimen is coupled to measuring spring bar and forms extension of it.

TOLERANCES

Clearance, Fits, and. Tolerances, Clarance and Fits in Machine Building (Toleranzen Spiele und Sitzarten im Maschinenbau), A. F. Lessochin. Werkstattstchnik (Berlin), vol. 24, no. 2, Jan. 15, 1930, pp. 44–48. Attempt is made to clear up fit and allowance problem along scientific lines; it is assumed that conditions in practical application follow law of probability which can be traced only by experiment; equations are developed; Czechoslovakian, German and ISA (international) standard proposals are analyzed.

TUBES

Ribbed. Investigation of Cooling Ribs (Undersokning av Kylflansar) M. Blomqvist. Teknisk Tidskrift (Stockholm), vol. 60, no. 3, Jan. 18, 1930 (Mekanik), pp. 5–13, 29 figs. Discussion of formulas for calculating effect of ribs; description of test made to check formulas and discussion of results obtained and comparison with theoretical figures from different formulas; tests show that square or rectangular ribs are more efficient than circular.

TURBO-BLOWERS

Large. The Largest Turbo Blast Furnace Engines in the World. Iron and Steel Industry (Lond.), vol. 3, no. 3, Dec. 1929, pp. 81–82, 3 figs. Description of two turbo blast-furnace engines in German blast-furnace plant designed to supply air for blast furnace capable of producing 1000 tons of pig iron per day; on normal service, each of these turbo-blowers takes in 2620 cu. m. of air per min. and compresses it at 2½ atmospheres when working at 2900 r.p.m.; blowers driven by high-pressure turbines.

TURBO GENERATORS

Testing. Testing Equipment for Steam Turbines in Testing Station of Muelheim Works of Siemens and Schuckert (Die Pruefeinrichtungen fuer Dampfturbinen im Grossen Prueffeld des Muelheimer Werkes der S.S.W.), A. Bross. Siemens-Zeit. (Berlin), vol. 9, no. 12, Dec. 1929, pp. 872–873, 2 figs. Plant which had been taken over from Thyssen has been extended so that double-casing 30,000-kw. unit and triple casing 50,000-kw. unit including generators, and units of same capacity without generators can be tested simultaneously; cranes can be coupled in such way that pieces of 100 tons can be handled.

W

WAGES

High. The Doctrine of High Wages, J. H. Richardson. Mech. World (Manchester), vol. 87, no. 2247, Jan. 24, 1930, pp. 73–75. High general level of real wages is mainly consequence and not cause of high rate of production per worker; important reactions between production and wages; in United States, with large home market and relatively small foreign market, method of raising wages is practicable; in Great Britain and other European countries where foreign markets and foreign competition are more important, method of raising money wages, could only be applied to much smaller extent; increase in productivity would result in higher real wages.

WATER

Critical Point. Research on the Critical Point of Water, J. Havlicek. Engineering (Lond.), vol. 129, no. 3338, Jan. 3, 1930, pp. 1–3, 4 figs. Account of theoretical investigation, made in 1915, in which author studied change from ideal liquid to ideal vapor, both phases retaining their ideal properties at all temperatures and at all pressures; equations deduced showed that border curves of ideal substance would meet in cusp and not in horizontal tangent and also that there was critical temperature above which only gaseous phase could exist, no matter how high the pressure.

Vapor Pressure. Effect of an Inert Gas under Pressure Upon Vapor Pressure of Water (Ueber den Einfluss eines indifferenten Gases unter Druck auf den Dampfdruck des Wassers.) J. J. van Laar. Zeit. fuer Physikalische Chemie (Leipzig), vol. 145, no. 3–4, Dec. 1929, pp. 207–219. Fact discovered experimentally by E. P. Bartlett, that steam pressure may be increased 4 times by introducing inert gas, such as nitrogen, under high pressure, say 100 atmos., is proved by mathematical discussion of author to follow directly and with quantitative precision from exact thermodynamic theories of energy.

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IN TWO SECTIONS—SECTION TWO

MECHANICAL ENGINEERING

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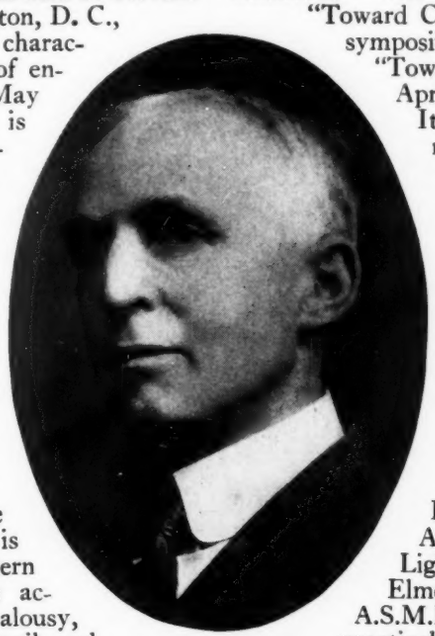
What It's All About

THE first half-century of the life of The American Society of Mechanical Engineers has come to its close with appropriate ceremonies observed in New York, which is the headquarters of the Society, in Hoboken, N. J., where the organization meeting was held at Stevens Institute, April 7, 1880, and at Washington, D. C., which provided a setting of a national character in which the international aspects of engineering could be discussed. The May issue of MECHANICAL ENGINEERING is largely devoted to a report of the Anniversary, and this supplement to it emphasizes a few high spots so that you may know "What It's All About."

Toward Civilization

IT IS NOT a function of engineering to concern itself with moral or spiritual matters. Engineering is, as President Hoover pointed out to the mechanical engineers and their distinguished guests at the Fiftieth Anniversary Dinner in Washington, entirely unemotional. It recognizes none save natural law to which its obedience is unquestioned and unswerving. The stern mandates of the physical world are accepted by it without fear, or hate, or jealousy, or joy, or sorrow. Beyond good and evil, and the necessity for the sustaining encouragement of hope, impersonal and impartial, it is man's tool and weapon by which he may build up or tear down, preserve or destroy. With man, and with him alone, do its functions and purposes become moral issues.



CHARLES A. BEARD

But engineers are moral beings. On them, whether they like it or not, rests the responsibility for the effects of engineering on their fellow-men and upon the world in which they are permitted for a short while to exercise their destructive or their constructive influences. And because of the potency of their craft, their obligations are great. Their critics are loud and severe.

Engineers are keenly conscious of the strategic position that they occupy in the modern world. They recognize their obligations, and they resent much of the criticism directed at them and at the so-called machine world they have helped to create. More used to deeds than to words, their refutation of the charges brought against them by their literary-minded critics has been meager and uncoordinated. But recently, under the editorship of Dr. Charles A. Beard, keen student of modern life and social progress, some of them have united in a defense and an exposition of the way of salvation which may be found, they agree, in the scientific method and the engineering approach to the solution of the problems of physical existence. This attempt on the part of engineers to be represented by able counsel in the court of public opinion has resulted in an answer to the question implied in another symposium edited by Dr. Beard, "Whither Mankind." The engineers' answer to this query is "Toward Civilization," and this is the title of the symposium.

"Toward Civilization" was published late in April by Longmans, Green & Company. It makes stimulating and interesting reading for layman and engineer alike. The list of the contributors to it contains names well known to engineers. Aside from Dr. Beard, who has edited the symposium and written the introduction and the summary, the following scientists and engineers have contributed chapters:

Ralph E. Flanders, manager, Jones and Lamson Machine Company, former president of the National Machine Tool Builders' Association, vice-president, A.S.M.E., writes on "The New Age and the New Man."

Robert A. Millikan, Nobel Prize winner, A.S.M.E. medalist, tells how "Science Lights the Torch."

Elmer A. Sperry, past-president of the A.S.M.E., famed for his contribution of many practical uses for the gyroscope, himself an inventor of international repute, has a chapter on "The Spirit of Invention in an Industrial Civilization."

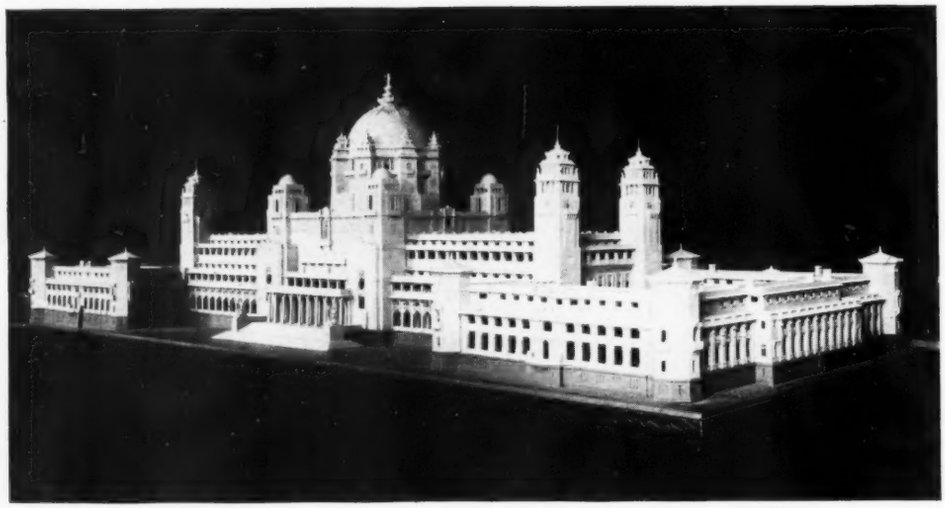
Clarence F. Hirshfeld, for many years director of research of the Detroit Edison Company, and frequent contributor to MECHANICAL ENGINEERING and other technical papers, has written on the important subject of power.

Roy V. Wright, managing editor of *Railway Age* and editor of *Railway Mechanical Engineer*, well-known authority on railway, marine, bus, and air transportation, contributes a chapter covering these phases of modern life.

Lee de Forest, pioneer in the field of radio telegraphy and telephony, and the talking moving pictures, scientist and inventor, writes on "Communication."

Dexter S. Kimball, dean of engineering, Cornell University, past-president, A.S.M.E., contributor to the Hoover report on "Recent Economic Changes," author and speaker on economic and managerial topics, has a chapter entitled "Modern Industry and Management."

Thomas D. Campbell, who operates the largest individually owned farm in the world, who has brought to the problem of agriculture the benefits of engineering and finance, writes on "Agriculture."



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L. W. Wallace, secretary of American Engineering Council, which represents 26 engineering societies with a total membership of 44,000, has contributed a chapter on "Engineering in Government."

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Oskar von Miller

DR. OSKAR VON MILLER, brilliant and distinguished head of the Deutsche Museum in Munich, Germany, is 75 years old, or "young" as he would prefer it, on May 7. What von Miller's contribution to an understanding of the scientific and industrial basis of civilization has been cannot be evaluated. In the great museum which he has built up in Germany it is possible to study the evolution of the arts, crafts, industries, and sciences by means of models and cleverly planned and constructed exhibits. The educational value of such study increases from year to year as science and industry progress. Engineers visiting Germany plan to spend several days in the Deutsche Museum. Dr. von Miller, admired, respected, and beloved by all who know him and his work, is an honorary member of the A.S.M.E. At seventy-five he retains the imagination and enthusiasm of youth.

Human Labor Most Expensive

WE ARE indebted to a correspondent for the photograph of the model of a new palace being built at Jodhpur, India. Architecturally beautiful as the building will be, most interesting to engineers is the fact that the stone is being quarried and the excavations and foundations are being prepared by modern methods, using modern power-driven tools. Even though these tools are expensive, writes our correspondent, they prove to be more economical than hand labor, even with wages as low as twenty cents a day for unskilled and seventy cents a day for skilled workers.

The A.S.M.E. Fiftieth Anniversary

IN APRIL, 1930, The American Society of Mechanical Engineers held its fiftieth birthday party, to which the entire world was invited. They came, delegates to the Anniversary, from Australia and South Africa, from Japan and South America, from Europe, from Canada, Mexico, and from all over the United States. They were representatives of engineering clubs and societies, of scientific organizations of colleges and Universities, of trade associations and business institutions. They brought beautifully engrossed greetings from the groups of engineers whom they represented, and they rose in response to an impressive roll call in the National Council Chamber of the United States Chamber of Commerce in Washington that lasted throughout an entire morning.

But they did more than this. The engineering profession in each of sixteen countries, including the United States, named a representative to receive one of the sixteen Fiftieth Anniversary Medals which were awarded during the celebration, and to prepare, with such assistance as his countrymen would give him, a monograph covering the humanistic aspects of engineering in his native land. Thus was the international character of engineering successfully demonstrated, and thus was testimony offered in support of the belief, held by engineers, that their craft has profoundly influenced the economic and sociological developments of modern times.

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Dramatic, too, was the convocation on Tuesday afternoon, at which the sixteen distinguished engineers, presented to the Society by the chief diplomatic officers of their respective countries, were awarded the Society's Fiftieth Anniversary Medal, and at which four other engineers received the A.S.M.E. Medal, the Gantt Gold Medal, the Daniel Guggenheim Medal, and the Melville Medal.

UNVEILING THE MEMORIAL TABLET, APRIL 5, 1930, ENGINEERING SOCIETIES BUILDING, NEW YORK, IN CONNECTION WITH THE A.S.M.E. FIFTIETH ANNIVERSARY

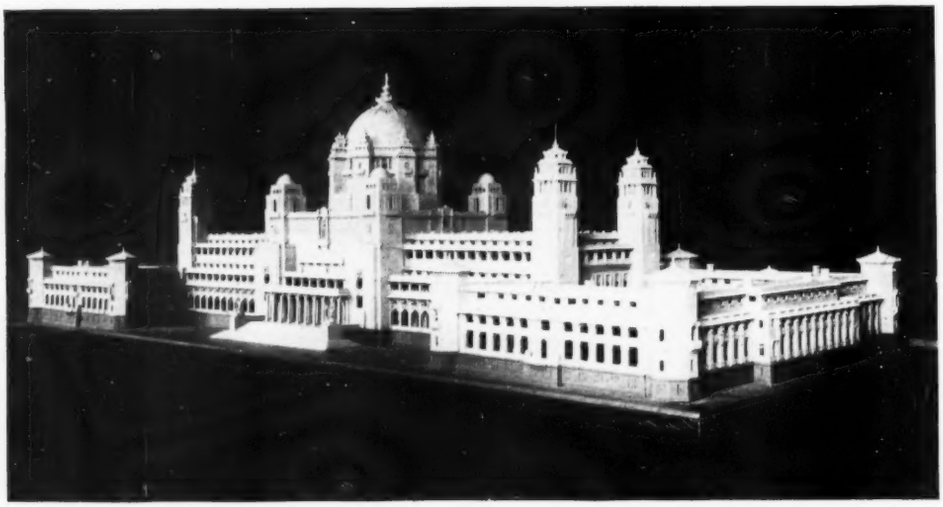
On the left of the tablet, reading from left to right, are Charles T. Main, Ambrose Swasey, and Francis Lee Stuart; on the right, in the same order, are John Sweet, Julio Kilenyi, sculptor, and Charles E. Gorton.

But the supreme event of all was the brilliant dinner, on Tuesday night, at which the President of the United States was the guest of honor, and at which the Hoover Gold Medal was instituted. This medal, which is to be awarded from time to time by engineers to a brother-engineer in recognition of distinguished public service, was presented to the engineer-statesman whose name it bears. The speech of acceptance, in which the engineer's relation to government was stressed, is published in full in the May issue of MECHANICAL ENGINEERING as part of the report of the meeting.

Aside from the presentation of the Hoover Gold Medal, the dinner was also the occasion for the delivery of an address by Dr. Robert A. Millikan on the bonds between physics and engineering. Those who read the abstract of this address in MECHANICAL ENGINEERING and the chapter entitled "Science Lights the Torch" of the symposium "Toward Civilization," mentioned elsewhere in this supplement, will realize that Dr. Millikan used the text of his contribution to the symposium for his Anniversary Dinner address.

The "Europa's" Bow

IN THE September, 1929, issue of MECHANICAL ENGINEERING notice was taken editorially of the liner



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OSKAR VON MILLER

Dramatic, too, was the convocation on Tuesday afternoon, at which the sixteen distinguished engineers, presented to the Society by the chief diplomatic officers of their respective countries, were awarded the Society's Fiftieth Anniversary Medal, and at which four other engineers received the A.S.M.E. Medal, the Gantt Gold Medal, the Daniel Guggenheim Medal, and the Melville Medal.

UNVEILING THE MEMORIAL TABLET, APRIL 5, 1930, ENGINEERING SOCIETIES BUILDING, NEW YORK, IN CONNECTION WITH THE A.S.M.E. FIFTIETH ANNIVERSARY

On the left of the tablet, reading from left to right, are Charles T. Main, Ambrose Swasey, and Francis Lee Stuart; on the right, in the same order, are John Sweet, Julio Kilenyi, sculptor, and Charles E. Gorton.

But the supreme event of all was the brilliant dinner, on Tuesday night, at which the President of the United States was the guest of honor, and at which the Hoover Gold Medal was instituted. This medal, which is to be awarded from time to time by engineers to a brother-engineer in recognition of distinguished public service, was presented to the engineer-statesman whose name it bears. The speech of acceptance, in which the engineer's relation to government was stressed, is published in full in the May issue of MECHANICAL ENGINEERING as part of the report of the meeting.

Aside from the presentation of the Hoover Gold Medal, the dinner was also the occasion for the delivery of an address by Dr. Robert A. Millikan on the bonds between physics and engineering. Those who read the abstract of this address in MECHANICAL ENGINEERING and the chapter entitled "Science Lights the Torch" of the symposium "Toward Civilization," mentioned elsewhere in this supplement, will realize that Dr. Millikan used the text of his contribution to the symposium for his Anniversary Dinner address.

The "Europa's" Bow

IN THE September, 1929, issue of MECHANICAL ENGINEERING notice was taken editorially of the liner

Bremen which had broken the speed record of crossing the Atlantic Ocean. More recently the *Bremen's* sister ship, the *Europa*, has clipped 18 minutes from that newly established record in her first crossing. The new record of 4 days, 17 hours, and 6 minutes from Cherbourg to Ambrose Light indicates an average speed of 27.99 knots. The designers of these speedy ships attribute their record-smashing ability to the "bulbous" bow. The accompanying photograph of the *Europa* in dry dock, shows this feature of the new ship. Such progress in marine engineering recalls M'Andrew's Hymn, in which Kipling says:

> We're creepin' on wi' each new rig—less weight and larger power:
> There'll be the loco-boiler next an' thirty miles an hour!
> Thirty an' more. What I ha' seen since ocean-steam began
> Leaves me na doot for the machine: but what about the man?

Rope Sense

THE hoists that are used to unload coal from barges at electric power plants require the use of large amounts of wire rope. When such an important item is purchased in large quantities the expense involved naturally leads to an investigation of the causes of wear which make replacement necessary. The investigations, in turn, are likely to lead to the discovery of practices and details of equipment design that can be changed to increase life and reduce maintenance. Such a procedure, as has been followed by the Philadelphia Electric Company, is "rope sense," and under such a title J. R. McCausland tells, in the May issue of MECHANICAL ENGINEERING, what this company has accomplished by means of a rational approach to its wire-rope problems. As one of the contributions made to a symposium held last fall under the auspices of Engineering Foundation, Inc., and the A.S.M.E., at which the subject of research in the field of wire rope was discussed, the paper is an indication that much valuable work is being done, and that a coordination of this and other efforts would bring out other much-needed information on this subject. MECHANICAL ENGINEERING comments editorially that the A.S.M.E. and the Engineering Foundation, Inc., stand ready to offer their services in assisting a program of research on wire rope.

Aluminum's New Role

AS STRUCTURES increase in size and as accelerations and decelerations grow greater, the importance of the relations of strength and weight of materials of construction becomes more evident. The Aluminum Company of America has recently commenced the operation of a mill for rolling strong but light structural shapes in duralumin. In MECHANICAL ENGINEERING for May is a brief description of the plant which is located at Massena, N. Y., and a discussion of the new role which aluminum is prepared to play as an engineering material.

A.S.M.E. Boiler Code Committee

THE nine pages of the May issue of MECHANICAL ENGINEERING devoted to revisions of the A.S.M.E. Boiler Code are evidence of the valuable work which the Society has directed since 1911. The various codes for the construction and operation of fired and unfired pressure vessels have been incorporated into the laws of twenty states and sixteen cities. The Boiler Code Committee, made up of representatives of the manufacturers and users of this type of equipment, meets every month to interpret its codes and rules and to act upon the revisions which changes and advances in engineering practice make necessary. Through MECHANICAL ENGINEERING the work of the Boiler Code Committee receives wide publicity.

THE "EUROPA" IN DRYDOCK, SHOWING THE "BULBOUS" BOW